The Central City:
Why the Comeback?

By

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Submitted to the Department of Architecture
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Abstract

Recently, scholars and non-scholars alike have written and spoken much about the reversal of urban sprawl and the in-migration of young professionals and empty nesters. The objective of this study is first, to examine the relative city performance for the three defined metrics to determine whether cities are leading or lagging their MSAs in each respective metric and second, to determine how differences in relative performance correlate to the independent variables. Additional analyses will be performed to determine changes in household composition and relationships between supply growth and demand growth.

This paper, using OLS regression techniques, examines the correlation between various measures of relative city to MSA growth performance (specified as relative population, housing unit and property value growth) and various independent variables for a representative sample of seventy three metropolitan areas. The study period includes data from 2000 to 2004. The twenty eight independent variables can be categorized into three major groups: (1) Demographic Characteristics (2) Environmental Characteristics and (3) Transportation Statistics.

The results show that, on average, central cities perform worse than their MSAs in terms of housing unit and population growth while outperforming in terms of property value growth. In central cities, housing units are growing faster than population, indicating either shrinking household size or increases in investor/second home demand. Considerable variation exists and averages do not tell the whole story. Certain independent variables, namely roadway miles and transit miles have strong correlations to relative growth metrics while others such as the city's proportion of total MSA population have no observable relationship. Another surprising result is that a city's proximity to a water amenity has negative correlation to its relative population, housing unit and property value growth rate.

Thesis Supervisor: William C. Wheaton
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I. INTRODUCTION

Today, urban planners, brokers and real estate developers confidently speak of the groundswell of population moving back into America's core cities. Many claim that sprawl is reversing. At a 1998 Association of Collegiate Schools of Planning Conference, panelists stated that the housing and the population shift associated with it is one of the best ways to revitalize downtown (Sohmer and Lang, 1999). To them, this demographic shift has already begun and will only increase in magnitude as the baby boom generation enters their golden years.

<u>Section 1.1</u> Urban Exodus

Scholars cite various reasons for the decline of downtown areas following World War II. Sohmer and Lang blame city planners for implementing the "policies of the 1960s and 1970s that over-zoned for office and retail uses and deliberately excluded residences from the central business district" (1999). Duany claims "somewhere along the way, through a series of small and well-intentioned steps, traditional towns became a crime in America" (Duany, Plater-Zyberk & Speck, 2000). He continues to explain the acceptance of sprawl by stating, "one of the largest segments of our economy, the homebuilding industry, developed a comprehensive system of land development practices based upon sprawl, practices that have become so ingrained as to be second nature" (Duany et al., 2000).

These policies mentioned by Sohmer and Lang "conspired to encourage urban dispersal" (Duany et al., 2000). The most significant of these, the loan programs administered by the Federal Housing Administration and Veterans Administration, provided end-user funding for the purchase of eleven million new single-family suburban homes with interest rates that resulted in mortgage payments that typically cost less than rent. As a result, these programs discouraged the renovation of existing housing or even the construction of new housing of more downtown-amenable types such as row houses and mixed-use buildings. In combination with these policies, the Interstate Highway Act of 1956 provided ninety billion federal dollars to construct forty-one thousand miles of highway, other federal and local subsidies provided further incentive to build roads, and the general neglect of transit systems all conspired to make automotive commuting cheap and easy for everyone. Given the improved highway system and degrading transit system, most returning GIs migrated from the central city to the periphery. Soon after, the retail followed the residents but since the subdivisions were funded only for residential development, the new retail had to locate separate from the population (Duany et al., 2000). Jobs remained downtown for some time, with people living in the periphery and commuting downtown as in the classic mono-centric city model (Wheaton, 1995). However, the situation changed in the 1970s when corporations moved their offices closer to their CEOs, who by this point lived in the suburbs. As a result, the mono-centric city became poly-centric and living, shopping and working all moved out of the center city, leaving the core to decay.

While the population acted rationally and moved outwards due to the new economic framework imposed by government programs, they would then be bound by law to sprawl through single-use zoning. Single-use zoning, very useful in Europe's industrialized cities to separate factories from residential areas, in America, expanded to separate everything from everything else (Duany et al., 2000).[1] As a result, dependency on the car has developed and suburban areas were better suited for the parking needs of a car-dependent citizenry. The pattern has continued unabated for fifty years and today results in California growing by the size of a Massachusetts every decade.[2]

Clearly, an in-migration will have significant impacts on policy and business decisions. Sophisticated urban planning will become critical to prevent a repeat of failed urban planning and renewal experiments of the 1960s and 1970s. Real estate developers, as the ultimate satisfiers of demand for built space, must understand the nature and extent of this shift so that they can develop buildings that have the right product mix in the right location.

[1] The typical zoning code today has dozens of land use designations separating not only factories from residential but low density from medium from high density residential. Offices and retail are often separated in the same manner.

[2] And this land growth is not equal with population growth: From 1970-1990 Los Angeles grew 45% in population and 300% in land use.

<u>Section 1.2</u> Theories on the Move Back Downtown

Various reasons have been given for the move back to the core city, many based on conjecture. According to Eugenie Birch of University of Pennsylvania, "anecdotal evidence suggests that people are living downtown because they want to be near work places and cultural amenities, and because they enjoy a bustling environment" (1998). The typical story told involves an empty nester couple who wish to sell their large, mostly empty suburban home for a smaller, more convenient urban condominium or townhouse. Adding to empty nester couples are mid to late twenties echo boomers, the children of the baby boomers, wishing to move downtown to remain close to work and to each other. Environmentalists cite rising fuel costs, loss of open space and increased air pollution as additional reasons that dense downtown living can be good for the pocketbook and your health (Sierra Club, 2006).

Drawing the diaspora back into central cities can provide significant and lasting benefits to the city. Average commutes, already at 24.3 minutes in 2003, can be significantly shortened by eliminating commuting or allowing city residents to reverse-commute to suburban offices (American Community Survey, 2003). The reduced vehicle dependence will result in better air quality and reduced rush-hour traffic jams. Mixing the uses by adding residential will create a safer, 24-hour city with retail establishments open after office hours. The vitality of pre-WWII central cities will return. Additionally, the growing central city population will draw businesses, office and retail back into the city, increasing tax base and removing the stigma associated with city living.

However, much of the talk about re-urbanization has been based on anecdotal evidence and conjecture. Specifically, the aging baby boomers are frequently cited as the source of this urban population growth (Baker, 2006). While the data exists, other than very recent studies, little rigorous analysis has been done to prove or disprove this theory. This thesis attempts to add to the body of knowledge concerning the nature, extent, and geographical distribution of this supposed move back to the core city by examining the relationship between central city growth and external factors such as *Percent Sunshine per Year*. Rather than only describing the demographic changes that have occurred in the past, I hope to lay a foundation for creating a model that can help predict where central city growth will occur in the future. A definitive, data-based answer will improve the decision-making ability of industry participants in regards to what, how and where to build the next generation of buildings.

In the following chapter, I will review the existing literature on the topic and draw out similarities and differences amongst the different points of view. Chapter 3 will then expand upon the questions I seek to answer and how they intertwine with existing research. I will also hypothesize on the results of my regression analysis. Chapter 4 will detail the analysis methodology and define the dependent and independent variables to be used. Results and analysis will follow in Chapter 5 with Chapter 6 will wrap up with conclusions and recommendations for further research.

II. PRIOR RESEARCH

A significant amount of research has been done by The Brookings Institution's Center on Urban and Metropolitan Policy. Eugenie Birch, an urban planning professor at University of Pennsylvania, conducted a survey of 24 cities nationwide in 1998 study entitled *A Rise in Downtown Living* which examined the 1998-2010 population growth expectations[3] from city officials. The involved city officials did not make clear nor standardize their projection methodology, so this study cannot to be considered strictly rigorous. Regardless, this report initiates the recent discussion on re-urbanization. Based on the survey, city officials' growth expectations ranged from 1.5% for Los Angeles to 303% for Houston.

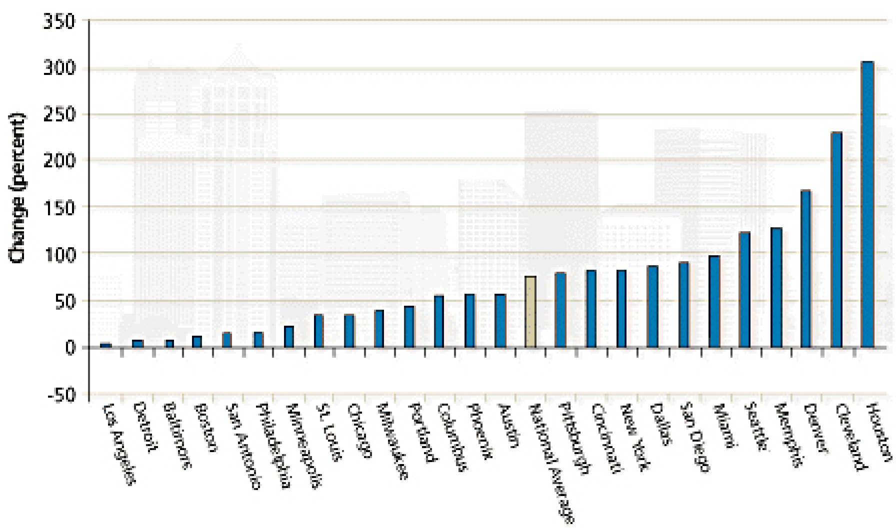

Figure 1: Expected Downtown Population Growth 1998-2010
Source: Sohmer and Lang, 1999

[3] Growth expectations came from examining developments underway, building permits and anticipated projects.

Interestingly, all cities surveyed, even ones that have lost population for decades (Philadelphia, Chicago, Detroit), expected downtown population to increase from 1998-2010. Clearly, city officials believe that downtowns will reverse the trend of population loss.

Drawing on the Census 2000 data, Rebecca Sohmer and Robert Lang authored a study, *Downtown Rebound,* which revealed that the actual number of people moving downtown is relatively small. They considered it "more of a trickle than a rush" (2000). One significant difficulty faced by Sohmer and Lang involved the definition of "downtown." By not focusing on a census-defined geographical entity such as *central city*, they were required to formulate their own definition of *downtown* for each metropolitan area studied. Their analysis revealed that the trends observed for downtown areas often ran counter to trends for the overall central cities, namely that downtown areas were gaining population relative to their MSAs while central cities continued to lose population relative to their MSA. This pattern, however, does not apply to all cities. Sohmer and Lang classified four different patterns: (1) The dominant *Downtown Up , City Down* (2) *Downtown Up , City Up* (3) *Downtown Down , City Up* (4) *Downtown Down , City Down,* each representing the growth pattern of the entire city vs. the downtown area. Additionally, the findings revealed that the gains were not uniformly distributed racially. According to the authors, Whites led the resurgence of downtown living (contrasted to the general decline in White city population) while Blacks and Hispanics were less well represented in the new trickle of downtown residents. Further detailing the demographic composition of the in-migrants, the authors argue that the shift will include significant numbers of empty nesters as baby boomers age and shift their lifestyle to one that prefers downtown amenities such as museums, concerts and easy access to good restaurants. Echoing earlier conjecture, the authors then argue that empty nesters "choose to downsize their housing – trading in the lawn care and upkeep of a large home for the convenience of living in a downtown condominium" (2000). The other cohort that is "probably aiding downtown's comeback" are childless Gen X and Y'ers in their 20s and 30s. These yuppies purportedly consume downtown amenities such as coffeehouses and nightclubs and prefer housing convenient to work and play while caring little about school quality, which continues to lag in downtown areas.

To address the weaknesses of prior studies and take advantage of the newly released Census 2000 data, Eugenie Birch released a follow-up study in 2002 funded by The Brookings Institution, Fannie Mae Foundation and the University of Pennsylvania. This study, *A Rise in Downtown Living: A Deeper Look*, selected a larger, regionally balanced sample of 45 cities and employed census data analysis in addition to surveys, field visits and interviews to compare city growth rates with downtown area growth rates. However, again by focusing on subjectively defined *downtowns*, Birch introduces potential confusion with regard to boundary definitions and also changing boundaries over time. In the end, Birch relied on city officials to define their own downtown boundaries. The results confirmed the heterogeneous growth patterns reported by Sohmer and Lang in *Downtown Rebound*. Using 1970 as a benchmark, Birch found that only 38% of sample cities had more downtown residents in 2000 than in the base year. Furthermore, 42% had downtown population loss from 1970-2000 even when their cities added residents. In comparison to their cities, only 33% of downtowns grew at faster rates. On a positive note, a decade-by-decade analysis revealed that the flight from downtowns was greatest during the 1970s (89% posted losses) and reversed significantly in the 1990s with 78% of sample downtowns gaining population. Finally, the proportion of residents living downtown varied dramatically depending on which city was examined. As an example, Birch noted that Boston and Philadelphia have roughly similar downtown population counts, but downtown Boston contains 14% of total Boston city population while Philadelphia has only 5% using the same metric.

Birch continued her research with *Who Lives Downtown*, a study released in 2005 that attempted to tease out further conclusions from the 2000 census data. This study provides the most complete look at downtown population composition and growth. Looking at growth by geography, Birch described strong regional trends from the 1970-2000 Census: the West experienced both downtown and city population growth, the Northeast experienced growing downtowns but declining cities, the South shrunk their downtowns while growing their cities and the Midwest losing population in both downtowns and cities. Expanding on her earlier comment about the calamitous 1970s, the author then showed that the downward trend slowed in the 1980s (47% of downtowns lost population) and completely reversed in the 1990s (70% gained population). This result meant that the shift towards downtown living began earlier than previously believed.

Birch then examined household growth and found it grew faster than population, growing 8% vs. 1% population decline from 1970-2000. This disparity has significant implications because household count and composition determines the number, size and layout of housing units demanded. More specifically, downtown demographic composition trends continued to shift towards singles living alone or together and away from families.

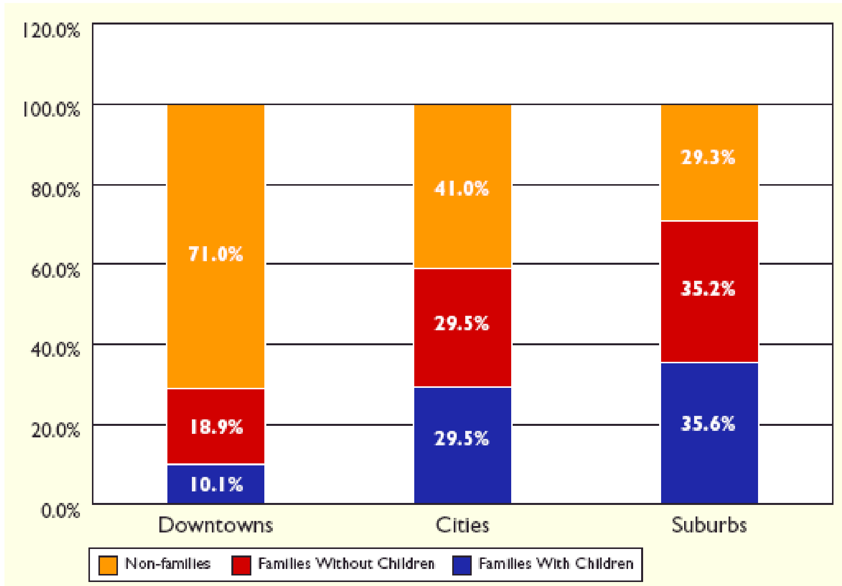

Figure 2: Household Composition of Downtowns, Cities and Suburbs
Source: Analysis of 2000 Census

Interestingly, Birch found that while the number of families without children decreased from 1970-2000 as a whole, the growth patterns followed the overall downtown growth patterns, namely strong negative growth in the 1970s, slower losses in the 1980s and significant increases in the 1990s. While we cannot parse out this subgroup into empty-nesters and childless younger marrieds, the data does weakly support the notion that empty-nesters are moving into downtowns.

Birch's racial composition findings match Sohmer and Lang's 2001 study in some areas and differ in others. The 2005 study notes a significant shift in racial composition with Hispanic and Asian residents growing substantially in representation while the number of Whites and Blacks remained relatively flat. It appears that Sohmer and Lang's comment that "White residents led the resurgence in downtown living" (2001) might have referred to the return of positive caucasian growth in the 1990s, however White population growth still significantly lagged Asian and Hispanic re-urbanization[4]. The largest conflict between Sohmer/Lang and Birch involved Hispanic re-urbanization with the former assigning little weight to this cohort and the latter noting its strong growth. In sum the downtown population exhibits far greater diversity than the suburbs, which remain 71% White. Of course, with all nationwide measures, considerable regional differences exist.

The next major finding by Birch confirms Sohmer and Lang's conjecture that the 25-34 and 45-64 cohorts drive downtown growth. The 25-34 age cohort increased 90% over the 30-year study period but made most of their gains between 1970-1990 with considerable slowing occurring recently. The aging baby boomers went from the largest group downtown in 1970 to a significantly declining group during the next two decades to an exploding demographic second only to the 25-34 year olds. Additionally, the study finds that educational attainment levels in downtown areas have grown disproportionately to overall national educational attainment. Downtown educational attainment levels are highest in the Northeast and Midwest and lag in the West and South. Finally, Birch found that downtowns contained some of the poorest households and some of the richest households in America, mirroring the diversity found in other demographic characteristics.

Finally, The Brookings Institution released a 2005 study entitled *Metro America in the New Century: Metropolitan and Central City Demographic Shifts Since 2000* which analyzed the changes since the last Census. In comparison to the other studies, the author, William Frey uses the well-defined central city and MSA definitions rather than attempting to formulate his own definition for downtown areas. Frey reports that the overall pattern of growth from 2000-2004 generally parallels those found in the 1990s rather than the mixed results of

[4] In the 1990s, Whites increased by 5% while Asians increased 39% and Hispanics increased 13%.

previous decades. Conversely though, because of shifting employment and housing dynamics, the fastest growing areas during the 1990s became some of the slowest growing areas in the 2000s. On a positive note, the majority of large central cities saw their population increase, generally sharing the rising and falling growth rates of their metro areas. Frey found that immigrants drive growth in many metropolitan areas, possibly reiterating Birch's assertion that Hispanic re-urbanization significantly drives downtown growth. Because of the different geographical comparison areas, Frey's results may not match up perfectly to previous research, however it does provide a glimpse into post-2000 Census patterns.

In addition to these scholarly national studies, there have been numerous city-specific studies and newspaper articles that echo similar sentiments, sometimes with little data-based support. The Center for Economic Development at Carnegie Mellon University released a 2005 study entitled *The Market for Housing in Downtown Pittsburgh* which analyzes data from Experian. The results agree with previous studies in that downtown growth has and will likely come from single young urban professionals and empty nesters with incomes above the regional average. Interestingly, Gradeck concludes that younger movers come from outside Pittsburgh while older movers to downtown come from the Pittsburgh region. It is unclear whether other metro areas experience this same bifurcated migration pattern.

Examining the studies as a whole reveals several major themes and a few differences between research findings. The first major theme echoed by several studies involves the heterogeneity of growth patterns by race, age and income distribution. The demographic metrics appear to include at least two cohorts and are not heavily focused on any one group, increasing the diversity of center city and downtown areas as compared to their suburbs.

Secondly, growth patterns differ over time with strong negative growth during the 1970s, weaker negative growth in the 1980s and a turnaround beginning in the 1990s. While future predictions cannot be relied upon, Birch's 1998 survey of city officials reveals that they predict strong downtown growth in the coming decades. Finally nearly all studies mention the strong likelihood that well-educated echo boomers and their baby boomer parents will comprise a significant portion of re-urbanizers.

In terms of differences, the first major difference between the studies involves geographical definitions. Birch relies on downtown boundaries determined by city officials verified by site visits and Sohmer and Lang also determine their own downtown boundaries, which may or may not coincide with Birch's definitions. The combination of Birch's lack of standardization, the possible differences between Birch and Sohmer and Lang's subjective downtown boundaries and changing boundaries over time makes comparison of their research more difficult. More positively, the difference in sophistication and rigor between studies has generally trended upwards. The conjecture and field surveys to determine estimates of growth from earlier studies have evolved into rigorous analysis of data that may only be slightly hampered by subjective geographical definitions. To the credit of earlier prognosticators, Birch's 2005 study provides reasonably sufficient confirmation of her own and Sohmer and Lang's earlier conjecture concerning the significant contribution of young professionals and aging baby boomers to the growth of downtown areas.

III. SPECIFIC AREA OF STUDY AND HYPOTHESIS

Section 3.1 Introduction to Specific Area of Study

As discussed in the literature review, previous studies have examined the extent, nature and composition of the move back downtown and derived several themes. Generally speaking, the move back downtown is occurring in a fragmented manner in terms of timing, geography and demographics.

I seek to expand on these foundational studies by examining how external factors correlate with relative measures of growth between the central city and its associated metropolitan statistical area (MSA). These relative measures include population, housing unit and residential property value growth. Whereas, generally speaking, the previous studies have described the past, a statistical analysis of independent correlated factors may help lay the foundation to generate a model to determine where central city growth will likely outperform metropolitan area growth in the future. For example, I will examine how an independent variable such as "Proportion of Adults 25 Years of Age and Up Who Have at Least a Bachelor's Degree" correlates with higher central city population, housing unit and property value growth relative to its MSA. Any relationship observed can be used to model future growth in other cities as they shift their own proportion of residents with high academic achievement.

In terms of variables for the statistical model, the growth metrics I will use as the dependent variable are Housing Unit Growth, Population Growth and Property Value Growth. Independent explanatory variables will be grouped in three main groups:

(1) Demographic Characteristics (2) Environmental Characteristics and (3) Transportation Characteristics. The details of individual variables within each group will be discussed later in the Methodology Section.

<u>Section 3.2</u> Hypotheses

The following hypotheses for each group of explanatory independent variables are set forth and will be examined empirically:

1. <u>Demographic Characteristics:</u> Cities with highly educated population and low crime rates will grow faster than their MSAs since the young professionals and empty nesters who desire city living will generally be more educated than the general population. Cities with large household size, however, will shrink in population relative to their MSAs because families with children will move out and be replaced by smaller, non-family households or childless baby boomer couples.

2. <u>Environmental Characteristics:</u> Strong relative growth will be associated with cities that have good climate, defined as high percentage of sunshine and minimal deviation from 65 degrees and those that are close to amenities such as major rivers, major lakes or oceans.

3. <u>Transportation Statistics:</u> I believe that cities where the relative inconvenience of commuting from the suburbs to the central city is low will result in poor central city growth rates. More specifically, highly developed transit networks, by making intra-city travel easier, will be correlated with higher city growth rates while high roadway miles will indicate easier inter-city commuting, resulting in lower city growth rates.

IV. METHODOLOGY

This study defines various measures of relative central city growth performance in population, housing units and property value and various measures of demographic, transportation and environmental metrics for each central city and attempts to quantify the relationship between the independent and dependent variables through statistical analysis of publicly available empirical data.

Statistical analysis will consist of ordinary least squares linear multiple regression techniques. Because the analysis involves growth rates, a logarithmic regression was attempted but due to the existence of multiple negative growth values, an analysis cannot be done using logarithmic transformation without losing the shades of negative magnitude. Before running the initial OLS regression, a correlation matrix will be examined to remove variables that exhibit high multicollinearity, defined as having a 0.6 correlation or greater.[5] Next, independent variables that exhibit little explanatory power are removed to improve the precision of remaining variables. At the same time, certain variables will be left across the various regressions (housing unit, population and property value growth) to show that variable's explanatory power for each respective regression.

Finally, an additional regression will be performed on data that has been cleaned of outliers. Outliers are defined as data points that result in standardized residual values greater than 1.96 or less than -1.96. Any significant changes to the regression results will be highlighted.

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5 While it is understood that considerable debate exists regarding the level of correlation required for multicollinearity to be suspected, I chose a widely accepted value of 0.6.

The OLS model used is specified as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ...$$

Where

β_0 : Y-intercept

$X_1 + X_2 + X_3, ...$: The set of independent variables. Of the twenty eight total independent variables, seven will be included in all three regressions to show their effect on the respective dependent variables.

$\beta_1, \beta_2, \beta_3, ...$: The set of coefficients, one for each independent variable.

<u>Section 4.1:</u> Data Sources and Discussion of Variables

First, it should be noted that the analysis focuses on 2000-2004 to determine more recent relationships between the variables. As noted in the literature review, growth rates have not moved linearly over the decades, therefore a focus on a smaller, more recent timeframe is desirable. Secondly, the analyses use readily available, Census-defined geographical boundaries in the same manner as Frey's 2005 study. Both the central city and the metropolitan statistical area (MSA) have data associated with them that do not require subjective interpretation. Pitfalls do exist, however. As the central city encompasses more of the MSA, the differences approach zero. Additionally, the use of central city rather than a subjectively determined downtown area does not allow for distinction between central city populations that live in the city core versus the city periphery, which in some MSAs could be considered essentially equivalent to a suburb. In spite of these challenges, a census-defined *central city* was chosen over a subjectively defined *downtown area* due to the more significant issues associated with the latter.

<u>Section 4.1.1</u> Dependent Variables

Three basic dependent variables will be used to represent relative growth performance for each central city and MSA. Additionally, these basic variables will be combined to represent other city growth performance metrics. The three basic dependent variables are (1) Population Growth (2) Housing Unit Growth and (3) Property Value Growth.

Population Growth: Census data from the Census 2000 and the 2004 American Community Survey were collected and annual population growth rates were calculated from these values to represent population growth for the central city and the MSA, respectively.

Housing Unit Growth: The calculation of housing unit growth used Census data for the baseline (2000) year. Because housing unit counts for 2000 exists for cities but not MSAs, the baseline year value will be represented by household count for both MSA and cities for consistency.[6] Housing unit counts for 2004 were calculated by adding housing unit growth figures from the American Housing Survey to the baseline counts. Note that the AHS counts represent gross additions to space and do not include demolitions and conversions. An appropriate annual growth rate was then calculated.

Property Value Growth: Growth in property value refers specifically to residential property. MSA annual growth rates were calculated using metro home price information from the National Association of Realtors for the years 2000-2005. Central city annual growth rates were obtained from Zillow.com based on data from the same period.

In order to determine relative performance between the central city and MSA, combination variables were created using these basic variables. For the three basic variables listed above, the difference between the city growth rate and the MSA growth rate for each basic variable will represent the relative growth of the city vs. the MSA for that basic variable. For example, should this difference be positive, it would mean that the city is growing faster than the overall MSA for that certain metric.

[6] The difference between housing units and households is vacant units. By assuming that vacancy is similar across the central city and MSA, household count can be used as a consistent replacement for housing unit count.

Section 4.1.2 Independent Variables

The analysis began with twenty eight total explanatory independent variables believed to have some effect on the dependent variables. The twenty eight could be divided into the three main groups: (1) Demographic Characteristics (2) Environmental Characteristics and (3) Transportation Statistics.[7] With such a large number of variables, some multicollinearity was expected. Therefore, before running any regressions, a correlation matrix was produced and when any two variables exhibited correlation coefficients with an absolute value greater than 0.65, one of them was removed. The new list of variables with highly correlated variables removed was then regressed against each dependent variable and variables that exhibited little explanatory power[8] were removed to improve both the t-statistics of the remaining variables and the R^2 of the overall model. However, some independent variables were left in place to demonstrate their lack of effect.

The final group of independent explanatory variables and their respective sources is listed in Table 1 on the next page, followed by a discussion of certain variables that deserve highlighting.

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[7] The entire list of initial variables and their sources can be found in Appendix I.

[8] Defined as having a t-statistic absolute value of less than 1.0

	Independent Variable	Source
Demographic	Average Household Size	US Census
	City as a Proportion of MSA (population)	US Census
	Crime Index	FBI Crime Data (2004)
	Median Age of Population	US Census
	Median Household Income	US Census
	Median Household Size	US Census
	Proportion of Population 25+ with Bachelors or Greater	US Census
Environmental	% Sunshine	National Climatic Data Center
	Combined Degree Days	National Climatic Data Center
	Major River Dummy Variable	Google Maps
	Large Lake / Ocean Dummy Variable	Google Maps
	Median Age of Housing Unit	US Census
Transportation	Avg. Daily Traffic per Freeway Lane Mile	Federal Highway Administration - Highway Statistics 2004
	Roadway Miles per 10,000 People	Federal Highway Administration - Highway Statistics 2004
	Transit Miles per 10,000 People	National Transit Database Report

Table 1: Final Group of Independent Explanatory Variables

While most variables are self-explanatory, certain nuances exist due to data collection limitations. First, it should be noted that demographic data generally came from the Census 2000 and also reflect the characteristics of the central city, due to data limitations. The following are additional independent variable nuances worth mentioning:

Percent Sunshine: Represents an estimate of the percent sunshine out of total possible sunshine. National Climatic Data Center lists an average over various numbers of years, anywhere from fifteen to one hundred nine years. For cities that were not represented in NCDC's dataset, the data for the closest city was used.

Combined Degree Days: Using an "ideal" baseline temperature of sixty five degrees Fahrenheit, every degree deviation in average daily temperature adds one degree day. When the average daily temperature exceeds sixty five degrees, a cooling degree day is recorded and when average daily temperature falls below sixty five degrees, a heating degree day is recorded. Combined degree days, therefore, represents the average total deviation from the ideal temperature for human comfort over the course of a year.

Major River and Large Lake/Ocean Dummy Variable: These two dummy variables were obtained by reviewing maps of the respective cities and determining whether they were located near major rivers, lakes or an ocean in order to test their correlation to various growth rates.

Crime Index: This independent variable was calculated by taking the proportion of total crime committed in the city and dividing it by the proportion of total population within the city as compared to the MSA. To ensure consistency of tabulation areas, the Index uses FBI definitions of "city" and "MSA" for both crime and population counts. Algebraically, it is represented as follows:

$$CrimeIndex = \frac{Crime_{City}}{Crime_{MSA}} \Big/ \frac{Pop_{City}}{Pop_{MSA}}$$

Transportation Statistics: To prevent varying geographical definitions of central city or MSA from muddying the data, whenever available, the population estimate given by the respective data source was used to determine transit/roadway miles per capita. By doing so, it ensures that the miles count and the population count represent the same geographical area.

City as Proportion of MSA: This variable represents what percentage of the MSA population resides in the central city. It tests for correlations with the dependent variables as the suburban cohort goes to zero. Additionally, as the proportion approaches one, the "relative growth rate" dependent variables should all approach zero.

Section 4.1.3 Statistical Sample

For the study, seventy three US cities were selected to obtain a representative sample with considerable variation in population, housing unit count, employment base and geography. Together, they represent thirty four states with cities in the Southeast, Northeast, Midwest, Southwest and Northwest along with the diverse employment bases they represent. The MSA population totals range from Lubbock, Texas with 257,790 to New York City with 18,718,300. The average metropolitan 2004 population for the sample is 2,307,022 which was undoubtedly skewed upwards by the large metropolises of New York City and Los Angeles. The median MSA population count stands at 1,398,420.

V. REGRESSION RESULTS

For each regression, following a restatement of the hypothesis, the specific dependent variable will be defined and summary statistics discussed. Then, the results of the initial regression on various explanatory variables will be presented with discussion on any independent variable that exceeds an absolute value t-stat of 1.0. We will then discuss changes to the regression results after removal of outliers and then conclude each regression discussion with comparison of actual results to the initial hypotheses.

Section 5.1 City minus MSA Population Growth (2000-2004 Annualized)

Population Growth Hypothesis – As hypothesized earlier, in terms of demographic variables, educational attainment should be positively correlated with relative city population growth while crime rate and household size will exhibit negative correlation. For environmental variables, combined degree days, a proxy for climatic adversity, should be negatively correlated while proximity to major rivers, lakes or oceans should be positively correlated to relative city population growth. And finally, for transportation variables, I expect strong relative city population growth to occur where difficult inter-city travel combines with efficient intra-city travel. Therefore, transit miles per capita should be positively correlated while roadway miles per capita should be negatively correlated to our relative population growth metric.

Section 5.1.1 Dependent Variable Transformation

Subtracting the MSA population annualized growth rate from the central city's rate gives the city's relative over-performance/under-performance compared to its associated MSA. The resulting population growth dependent variable shows whether people are moving into or out of cities, relatively speaking. First, a summary of the results of this transformation of seventy three city/MSA pairs is shown below in Table 2. The detailed results can be found in Appendix II.

Central City minus MSA Population Growth 2000-2004 (annualized)	
Average	-0.69%
Median	-0.68%
Standard Deviation	0.77%
Maximum	1.09%
Minimum	-2.41%
Positive Values	17
Negative Values	56

Table 2: Population Growth Summary (City minus MSA)

In this summary, the measures of central tendency indicate that most cities are lagging their MSAs in population growth. In fact, only 23% of cities in the sample grew faster, on an annualized basis, than their associated MSA. This result confirms Sohmer and Lang's 2005 findings. Raleigh, NC leads the relative city population growth with a 1.09% advantage while Washington, DC lagged its MSA by 2.41%.

<u>Section 5.1.2</u> Regression Results and Discussion

Regressing relative city/MSA population growth on twelve independent variables results in a R^2 of 0.46. Of the independent variables, six exhibit t-stats with absolute values greater than 1.0:

1. *Average Daily Traffic Per Freeway Lane Mile:* With a t-stat of -3.24, there is only a 0.2% chance that this variable has no observable relationship to relative city population growth, meaning that this coefficient has significant explanatory power. The coefficient of -1.082×10^{-6} implies that for every 1,000 vehicle increase in average daily traffic per freeway lane mile, the city population growth rate is 0.11% lower relative to its MSA. Intuitively, this makes sense as it would appear that higher traffic on the freeways of an MSA implies that people are likely to be living in a different city than their place of work. Additionally, this rejects the hypothesis that higher traffic which increases the cost of inter-city travel should be postively correlated to relative city growth. Also, the results do not support the notion that high-traffic MSAs will see residents flocking into central city residences to avoid commuting.

2. *City as Proportion of MSA (Population)*: With a t-stat of 1.13, this variable has marginal explanatory power. However, the coefficient of 0.007 is at least in the right direction. Recall that on average, cities lagged MSAs in population growth so therefore as cities become essentially the same as MSAs by approaching one, the deficit decreases.

3. *Combined Degree Days*: A t-stat of -1.22 with a coefficient of -8.223×10^{-7}, while not having strong explanatory power, at least matches the direction of the hypothesis. It appears that as cities become more inclement, they do worse compared to their MSAs. Intuitively, this makes sense as people in harsher climates

are less willing to get out of their cars and embrace the walking/transit required in denser central city living.

4. *Crime Index:* With a t-stat of -1.44, there's a 15% chance that Crime Index has no observable relationship to relative city population growth. Therefore Crime Index moderately explains the variance in relative city population growth. The coefficient of -0.0024 implies that for every unit increase in the Crime Index, the city population growth rate lags its MSA by 0.24%. Again, intuitively this makes sense and confirms the hypothesis because it implies that cities that higher crime rates do not attract residents, especially larger households such as families, as quickly as the safer suburbs.

5. *Major River Dummy:* With a t-stat of -1.37 on a coefficient of -0.0022, it appears that this moderate explanatory power variable counters the hypothesis. For some reason, a city's location next to a major river correlates with less population growth relative to its MSA. Potentially, the fact that many of the cities near major rivers in the US are used for industrial traffic and historically industry located near these rivers, residents often prefer suburbs in those cities.

6. *Roadway Miles per 10,000 Population:* While this explanatory variable has a strong t-stat of -2.84, the coefficient is only -.0003, implying that every additional roadway mile per 10,000 population correlates to only 0.03% lag in city population growth. For the sample, the average RM per 10,000 stands at 43.0 with a standard deviation of 12.0, therefore while roadway miles has strong explanatory power, the effect is not overpowering. Intuitively, the direction of correlation makes sense and provides supporting evidence, however weak, for the hypothesis and Duany's assertion that roadway construction promotes central city population drain (2000).

The complete regression results are shown on the next page in Table 3:

Regression Statistics	
Multiple R	0.674989051
R Square	0.455610219
Adjusted R Square	0.335659929
Standard Error	0.006305528
Observations	73

Independent Variable	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.033138941	0.036427667	0.909718997	0.366610772	-0.039727241	0.106005123
Average Daily Traffic Per FLM	-1.08153E-06	3.33728E-07	-3.240749347	0.001946886	-1.74908E-06	-4.13973E-07
Average Household Size	0.001323472	0.007867607	0.168217872	0.866977642	-0.014414085	0.017061029
City as proportion of MSA (Population)	0.00700079	0.006184478	1.131993726	0.262140939	-0.005370007	0.019371588
Combined Degree Days	-8.22324E-07	6.70639E-07	-1.226179976	0.224921624	-2.1638E-06	5.19154E-07
Crime Index	-0.002425293	0.001683045	-1.441014946	0.154779116	-0.005791884	0.000941298
LargeLake/Ocean Dummy	0.000263464	0.001893493	0.139141813	0.889804075	-0.003524086	0.004051014
Major River Dummy	-0.002278904	0.001658247	-1.374285669	0.174464842	-0.005595891	0.001038082
Median Age	-0.000166257	0.000479697	-0.34658684	0.730114309	-0.001125794	0.000793281
Median Age of Housing Unit	-6.32037E-05	9.02042E-05	-0.700673475	0.486215207	-0.000243639	0.000117232
Median HH Income	-1.85856E-08	1.82948E-07	-0.101589391	0.919421339	-3.84536E-07	3.47365E-07
Prop. w/ Bachelors or Greater	-0.001561947	0.020580161	-0.075895752	0.939754537	-0.042728397	0.039604504
Roadway Miles per 10,000 population	-0.000273832	9.65236E-05	-2.836945794	0.006203067	-0.000466908	-8.07562E-05

Table 3: City minus MSA Population Growth Regression Results

Because the OLS regression method assumes no outliers, removal of data with significant residuals will likely improve the model's explanatory power. By removing the two data points that have standardized residuals with an absolute value greater than 1.96 and regressing the resulting truncated dataset, the R^2 improves to 0.51. The explanatory power of five of the aforementioned variables improves and one declines. The changes include:

1. *Average Daily Traffic Per Freeway Lane Mile:* T-stat improves to -3.71 and the coefficient increases in magnitude to -1.125×10^{-6}.

2. *City as Proportion of MSA:* T-stat improves to 1.32 and coefficient gains very little magnitude to 0.0074.

3. *Combined Degree Days:* T-stat for this independent variable goes to -1.54 with an increase in coefficient magnitude to -9.261×10^{-7}.

4. *Crime Index:* T-stat improves to -1.45 but at the same time, the coefficient decreases in magnitude to -0.0022

5. *Major River Dummy:* The t-stat degrades significantly to -0.78 and the coefficient nearly halves to -0.0011. This variable no longer crosses the established threshold and therefore cannot be reliably analyzed.

6. *Roadway Miles per 10,000 Population:* T-stat improves to -2.89 and the coefficient remains the same at 0.003.

Table 4 on the next page details the complete results of the truncated dataset regression:

Regression Statistics	
Multiple R	0.71502438
R Square	0.511259864
Adjusted R Square	0.410141215
Standard Error	0.005597343
Observations	71

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.009251986	0.033128946	0.279271965	0.78102957	-0.057062803	0.075566775
Average Daily Traffic Per FLM	-1.12536E-06	3.03128E-07	-3.712486873	0.000462456	-1.73214E-06	-5.18583E-07
Average Household Size	0.00698786	0.007202741	0.970166776	0.335991901	-0.007429993	0.021405714
City as proportion of MSA (Population)	0.00742244	0.005637647	1.316584752	0.193156803	-0.003862536	0.018707416
Combined Degree Days	-9.26054E-07	6.01068E-07	-1.540681254	0.128832967	-2.12922E-06	2.77114E-07
Crime Index	-0.002193125	0.001507773	-1.454546238	0.15118561	-0.00521126	0.00082501
LargeLake/Ocean Dummy	0.000851645	0.00170186	0.500420193	0.618672838	-0.002554998	0.004258288
Major River Dummy	-0.001180172	0.001509049	-0.782063042	0.43735868	-0.004200863	0.001840519
Median Age	5.58204E-05	0.000433317	0.128821038	0.897944931	-0.000811558	0.000923199
Median Age of Housing Unit	-2.99706E-05	8.21508E-05	-0.364824962	0.71656898	-0.000194413	0.000134472
Median HH Income	-8.66978E-08	1.65485E-07	-0.523899839	0.602344517	-4.17953E-07	2.44557E-07
Prop. w/ Bachelors or Greater	0.00651672	0.018934886	0.344164711	0.731967124	-0.031385572	0.044419011
Roadway Miles per 10,000 population	-0.000250767	8.67691E-05	-2.890050678	0.005410321	-0.000424455	-7.70799E-05

Table 4: City minus MSA Population Growth Regression Results (with outliers removed)

The relative city population growth regression results confirm some hypotheses while rejecting others. Specifically, Crime Index, Combined Degree Days and Roadway Miles per 10,000 Population were confirmed to be negatively correlated with relative city growth performance while the prediction for Combined Degree Days appeared to be weakly confirmed. While City Share of MSA does not appear to be significant, the coefficient is in the correct positive direction. More interestingly, household size, proximity to water amenities and transit miles showed no significant relationship to the population growth metric.

<u>Section 5.2</u> City minus MSA Housing Unit Growth (2000-2004 Annualized)

Housing Unit Growth Hypothesis – The hypotheses for relative housing unit growth mirrors the population growth predictions. Educational attainment should be positively correlated with relative housing unit growth while crime rate and household size will have the opposite relationship. For environmental variables, combined degree days, a proxy for climatic adversity, will have a negative relationship while proximity to water amenities should be positively correlated to relative city housing unit growth. And finally, for transportation variables, I expect relative city housing unit growth to occur most strongly where difficult inter-city travel combines with efficient intra-city travel. Again, that implies that transit miles will trend in the same direction as relative city housing unit growth while roadway miles will exhibit a negative correlation.

<u>Section 5.2.1</u> Dependent Variable Transformation

Subtracting the MSA annualized housing unit growth rate from the central city's rate gives the city's relative over-performance/under-performance compared to its associated MSA. The resulting dependent variable shows whether housing units are being added to cities faster than to MSAs. This difference in growth rates may or may not match the population growth metric for each city/MSA pair. For example, if housing units are growing faster in cities but the people moving in are singles displacing families, population growth for that city/MSA pair may favor the MSA. First, a summary of the results of this transformation of seventy three city/MSA pairs are shown on the next page in Table 5. The detailed results can be found in Appendix II.

Central City minus MSA Housing Unit Growth 2000-2004 (annualized)	
Average	-0.60%
Median	-0.69%
Standard Deviation	0.84%
Maximum	1.60%
Minimum	-2.38%
Positive Values	14
Negative Values	59

Table 5: Housing Unit Growth Over/Under Performance Summary

In comparison to the relative city population growth outcome variable, the summary statistics for City minus MSA Housing Unit Growth show that average relative city housing unit growth has a smaller negative magnitude and higher maximum and minimum values. So while the number of city/MSA pairs with positive housing unit growth metrics lags the count for positive population growth metric values, it appears that overall, more housing units are being added to cities than population. The maximum value occurs in Bakersfield, CA with 1.60% relative city housing unit growth while Las Vegas city lags its MSA by 2.38%. Growth in housing units more accurately approximates growth in households since each household demands a housing unit while each person may not. The dependent variable summary statistics imply shrinkage in average household size. This provides support for earlier studies that assert that families are moving out of central cities while singles and empty nesters are moving in.

Section 5.2.2 Regression Results and Discussion

Regressing relative city/MSA housing unit growth on the same twelve independent variables results in a R^2 of 0.48. Of the independent variables, seven exhibit t-stats with absolute values greater than 1.0:

1. *Average Daily Traffic Per Freeway Lane Mile:* With a t-stat of -3.19, this transportation statistic has significant explanatory power. The coefficient of -4.599×10^{-7} combined with the higher t-stat implies that this variable has a more significant and stronger effect on housing unit growth than on population growth. This confirms the stated hypothesis. Again, the results do not support the notion that high-traffic MSAs will see households flocking into central city residences to avoid commuting.

2. *Average Household Size:* With a t-stat of 2.69 and a coefficient of 0.022, average household size shows significant positive correlation with housing unit growth. Note that the average value for household size in our sample is 2.48 with a standard deviation of only 0.23, meaning that while the effect is significant, there is not much deviation in terms of actual values. Despite this low effect, this relationship runs counter to the belief that a higher proportion of empty nesters and echo boomers (who generally have smaller household sizes than families) will result in higher relative city housing unit growth. Alternatively and plausibly, it could be that cities that currently have many larger family households are experiencing net out-migration of families and the smaller households that replace them require additional housing units to provide for the shrinking average household size. This result does not confirm the hypothesis.

3. *Major River Dummy Variable:* Surprisingly, proximity to a major river does not appear to correlate with higher relative central city housing unit growth rates. With a t-stat of -2.33 and a coefficient of -0.004, a city close to a major river appears to

grow in housing units 0.4% slower than its MSA. This runs counter to the stated hypothesis.

4. *Median HH Income:* Higher income appears to correlate with lower relative central city housing unit growth rates. A t-stat of -2.36 with a coefficient of -7.283×10^{-6} shows strong significance with a reasonably strong effect. The income data has an average of $37,164 and a standard deviation of $7,626 showing that considerable variation in household income exists across the sample. This provides support to the argument that echo boomers and to a lesser extent, retiring baby boomers are moving back into cities because in general, younger professionals and older retirees earn less than their middle aged counterparts. This is inconclusive, however because it could also imply that cities that have high poverty rates do not attract building. Therefore, additional research is necessary to determine exact income distribution across the sample cities.

5. *Median Age:* A t-stat of 2.65 and a coefficient of 0.0013 imply strong explanatory power yet weak effect. The summary statistics for median age data show that with an average age of 33 and a standard deviation of only 2 years, there is not much variation across the sample cities.

6. *Median Age of Housing Unit:* With a t-stat of -1.02 and a coefficient of -9.778×10^{-5}, this variable has marginal explanatory power. It is however, interesting in that cities with older existing stock do worse, indicating that perhaps the redevelopment of older buildings is not occurring at a very fast rate. It could also be a proxy for complexity of zoning laws, as more strict cities may have older housing stock as a result of their Byzantine laws.

7. *Proportion of Population 25+ with Bachelors or Greater:* With a very strong t-stat of 3.31 and a coefficient of 0.07, higher education correlates significantly and strongly with higher relative central city growth. The data has an average of 26% and a standard

deviation of 8%, showing reasonably large variation in sample data. This result provides support for Birch's 2005 assertion and the hypothesis that highly educated people are moving back downtown.

8. *Roadway Miles Per 10,000 Population:* Despite having a strong t-stat of -1.74, this variable's coefficient is only -0.0001. Additionally, the 95% confidence interval for the coefficient includes zero. So while roadway miles appears to have a negative correlation with housing unit growth, it does not respond as strongly as it did with population growth. However, assuming the negative correlation holds, however weak, it provides additional support for Duany's assertion that roadway construction causes flight from the central city (2000).

The complete regression results are shown on the next page in Table 6:

Regression Statistics	
Multiple R	0.689292
R Square	0.475123
Adjusted R Square	0.370148
Standard Error	0.00667
Observations	73

Independent Variable	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.081348942	0.038854083	-2.093703835	0.040520475	-0.159068678	-0.003629206
Average Daily Traffic Per FLM	-1.13617E-06	3.55957E-07	-3.191869832	0.002250718	-1.84819E-06	-4.24148E-07
Average Household Size	0.022641505	0.008391662	2.698095563	0.009042635	0.005855683	0.039427327
City as proportion of MSA (Population)	0.000977190	0.006596421	0.148139404	0.882729486	-0.012217616	0.014171996
Combined Degree Days	6.09569E-07	7.15310E-07	0.852174288	0.397506134	-8.21264E-07	2.04040E-06
Crime Index	-0.000894188	0.001795151	-0.498113012	0.620225346	-0.004485025	0.002696649
LargeLake/Ocean Dummy	0.001151576	0.002019617	0.570195381	0.570674286	-0.002888259	0.005191411
Major River Dummy	-0.004126580	0.001768701	-2.333113310	0.023012553	-0.007664508	-0.000588651
Median Age	0.001356079	0.000511650	2.650405816	0.010264883	0.000332627	0.002379530
Median Age of Housing Unit	-9.77757E-05	9.62126E-05	-1.016246140	0.313592711	-0.000290230	9.46782E-05
Median HH Income	-4.59921E-07	1.95134E-07	-2.356948205	0.021706965	-8.50247E-07	-6.95946E-08
Prop. w/ Bachelors or Greater	0.072794613	0.021950988	3.316234050	0.001552441	0.028886100	0.116703126
Roadway Miles per 10,000 population	-0.000179799	0.000102953	-1.746422274	0.085855441	-0.000385736	2.61372E-05

Table 6: City minus MSA Housing Unit Growth Regression Results

Removing the four outliers with standardized residuals greater than 1.96 or less than -1.96 results in a new regression where R^2 improves to 0.54. The explanatory power of three of the aforementioned variables improves. The changes include:

1. *Major River Dummy Variable:* T-stat improves to -2.85 with very little change in coefficient.

2. *Median Age:* T-stat improves to 3.30 with very little change in coefficient.

3. *Median Age of Housing Unit:* The t-stat on median age of HU increased to -1.73 with a coefficient of 0.0002. While significance is reasonably high, the coefficient value does not imply much effect.

4. For five variables (*Average Daily Traffic per Freeway Lane Mile, Average Household Size, Median Household Income, Proportion with Bachelor's or Greater and Roadway Miles)* the regression on the truncated dataset resulted in lower t-stats, but all remain above the t-stat threshold of 1.0.

Table 7 on the next page details the complete results of the truncated dataset regression:

Regression Statistics	
Multiple R	0.732276364
R Square	0.536228673
Adjusted R Square	0.436849103
Standard Error	0.005437345
Observations	69

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.068270803	0.03248759	-2.101442538	0.040114306	-0.133351266	-0.003190341
Average Daily Traffic Per FLM	-6.15785E-07	3.24003E-07	-1.90055344	0.062512516	-1.26484E-06	3.3271E-08
Average Household Size	0.014841308	0.007029156	2.111392777	0.039214669	0.000760218	0.028922399
City as proportion of MSA (Population)	0.00314795	0.005744472	0.54799633	0.585872283	-0.008359611	0.01465551
Combined Degree Days	6.01705E-07	6.19128E-07	0.971859056	0.3352999	-6.38557E-07	1.84197E-06
Crime Index	-0.001248221	0.001472401	-0.847744995	0.400188858	-0.004197795	0.001701354
LargeLake/Ocean Dummy	0.001329083	0.001665502	0.798007178	0.428237439	-0.002007319	0.004665485
Major River Dummy	-0.004216806	0.001480036	-2.849122835	0.006122595	-0.007181675	-0.001251936
Median Age	0.001392557	0.000422227	3.298125967	0.001694925	0.000546735	0.002238378
Median Age of Housing Unit	-0.000150394	8.6884E-05	-1.730978857	0.088962478	-0.000324444	2.36552E-05
Median HH Income	-3.38443E-07	1.62672E-07	-2.08052373	0.042064441	-6.64314E-07	-1.25718E-08
Prop. w/ Bachelors or Greater	0.048011712	0.01889595	2.540846629	0.013856822	0.010158575	0.085864849
Roadway Miles per 10,000 population	-0.000138539	8.72987E-05	-1.586953595	0.11815415	-0.000313419	3.63413E-05

Table 7: City minus MSA Housing Unit Growth Regression Results (with outliers removed)

The relative city housing unit growth regression results confirm some hypotheses while rejecting others. Specifically, Roadway Miles per 10,000 Population was weakly confirmed to be negatively correlated to relative city growth performance while Proportion of Bachelor's exhibited the predicted positive correlation in a more significant manner. The results for the Average Household Size and the Major River Dummy Variable, however, ran counter to the prediction. Interestingly, Age of Housing Unit exhibited negative correlation to our dependent variable, indicating that redevelopment is not occurring very quickly. Again, while City Share of MSA does not appear to be significant, the coefficient is in the correct positive direction. The other water amenity variable, Large Lake / Ocean Dummy Variable showed no significant relationship to the dependent variable and neither did the proxy for climatic adversity, namely Combined Degree Days.

<u>Section 5.3</u> Housing Unit Growth vs. Population Growth (2000-2004 City Only)

Reviewing the summary statistics of the two previous dependent variables, City Population Growth and City Housing Unit Growth (relative to the MSA), reveals that average housing unit growth outpaces average population growth. Additionally, both the minimum and maximum observations of the housing unit growth dependent variable are higher than the corresponding population growth observations. This comparison of measures of central tendency, however, does not allow observation of individual data points and could be skewed by a few extreme outliers.

By plotting Annual City Housing Unit Growth against Annual City Population Growth and drawing a 45 degree line, we can observe the overall pattern with better resolution than can be provided by simple summary statistics.[9] An observation that lies on the 45 degree line has equivalent housing unit and population growth. Any deviation from this line would indicate likely changes in household composition. The resulting plot can be seen below in Figure 3 and the complete data table is included in Appendix III.

[9] Note that the two variables represent City growth rates and not the linear difference between city and MSA growth rates as before.

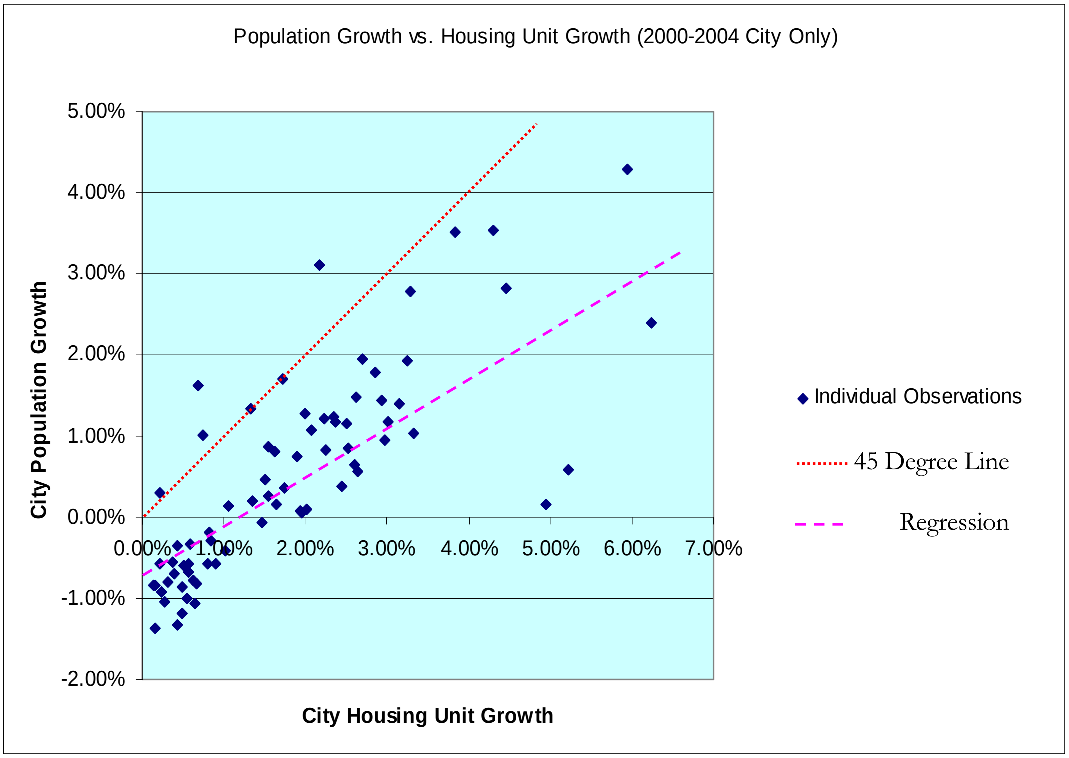

Figure 3: Population vs. Housing Unit Growth

In the figure above, the finely dotted line represents linear growth in both housing units and population. Of the seventy three cities, only Wichita, Fresno and New York City lie very near or on the forty five degree line.[10] Additionally, Fort Wayne, Riverside (CA) and Los Angeles lie above the linear growth line, implying that population has outpaced housing unit growth in these cities. The majority of cities lie below the forty five degree line with a large cluster exhibiting zero to one percent housing unit growth with zero to negative one percent population growth.

Examining the majority of cities again, we can clearly see that they appear to arrange themselves in a near-linear manner with a slightly negative y-intercept. Performing a

[10] Only Wichita, with 1.33% population and 1.33% housing unit growth, is exactly on the line. Fresno has 1.72% and 1.71% growth and New York City has 0.22% and 0.30% growth, respectively.

univariate regression yields a model with a R^2 of 0.61, a y-intercept of -0.74% and a coefficient estimate of 0.690 with a very high t-stat of 10.56. The least squares fit line appears on Figure 3 as a dashed line. With a slope of less than one, it appears that the model predicts that as housing growth accelerates, the disparity between HU growth and population growth grows even larger. This could derive from various reasons. Potentially, cities with very rapid housing unit growth have very aggressive redevelopment initiatives and therefore have development far outpacing what would occur in an unadulterated market. An innocuous explanation is that cities with a large disparity between housing unit and population growth could simply be experiencing greater shrinkage in household size due to families moving out and singles moving in. Cynically, perhaps the cities with significant development activity attract not residents, but frenzied investors looking to gamble with downtown condominiums rather than Internet stocks.[11]

[11] Not surprisingly, Las Vegas appears towards the upper right, with HU growth of 4.46% on only 2.83% population growth.

Section 5.4 Population minus Housing Unit Growth (City Only)

By examining the dependent variable, Population minus Housing Unit Growth, more light can be shed on this growth disparity. Again, this analysis cannot determine the cause behind the divergence but can only show where it occurs and what external factors are correlated to it.

Section 5.4.1 Dependent Variable Transformation

Subtracting annualized City Population Growth from annualized City Housing Unit Growth gives us the rate at which population outpaced/lagged housing unit growth for each of the seventy three cities in the sample. The resulting dependent variable will be regressed against nine independent variables. First, a summary of the results of this transformation are shown below in Table 8. The detailed results can be found in Appendix III.

Population Growth minus Housing Unit Growth (City Only)

Average	-1.30%
Median	-1.25%
Standard Deviation	0.90%
Maximum	0.94%
Minimum	-4.80%
Positive Values	5
Negative Values	68

Table 8: Population minus Housing Unit Growth (2000-2004 City)

The summary statistics clearly show that, on average, population growth in cities lags housing unit growth. At 0.94%, Riverside, CA had the greatest relative population growth disparity while on the other end, Atlanta's population growth lagged housing unit growth by 4.8%. Overall 93% of cities experienced higher housing unit growth than population growth. The dependent variable summary statistics imply shrinkage in average household size. This provides further support for earlier studies that assert that families are moving out of central cities while singles and empty nesters are moving in.

Section 5.4.2 Regression Results and Discussion

Regressing Population minus Housing Unit Growth on nine independent variables results in a model with a R^2 of 0.246. Of the independent variables, only two exhibit t-stats with absolute values greater than 1.0:

1. *Proportion of Population 25+ with Bachelors or Greater:* The educational achievement level of the populace appears to provide the best predictor of housing unit growth outpacing population growth. With a t-stat of -2.99, this transportation statistic has significant explanatory power. The coefficient of -0.48 combined with the high t-stat implies that this variable has significant and strong effects on the dependent variable. This provides support to the explanation that shrinking household sizes are responsible for housing unit growth outpacing population growth since the implicated inward moving empty nesters and young professionals tend to have higher education than the general population.

2. *Median Age:* With a t-stat of -1.44 and a coefficient of -0.0007, median age appears marginally significant with a weak effect on the dependent variable. Despite this, the result provides support to the belief that younger professionals are moving into cities and causing household composition shifts.

The complete regression results are shown on the next page in Table 9:

Regression Statistics	
Multiple R	0.495882222
R Square	0.245899178
Adjusted R Square	0.13817049
Standard Error	0.00836403
Observations	73

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.0112825	0.0231876	0.4865747	0.6282482	-0.0350542	0.0576191
City as proportion of MSA (population)	0.0027728	0.0067471	0.4109699	0.6824892	-0.0107101	0.0162558
Major River Dummy	0.0011222	0.0021395	0.5245058	0.6017675	-0.0031532	0.0053975
Median Age 2000	-0.0007423	0.0005142	-1.4435368	0.1538238	-0.0017698	0.0002853
Median Age of Housing Unit	0.0001180	0.0001330	0.8871296	0.3783833	-0.0001478	0.0003838
Median HH Income	0.0000001	0.0000002	0.4469333	0.6564559	-0.0000003	0.0000005
Percent Sunshine	0.0000903	0.0001301	0.6939814	0.4902450	-0.0001697	0.0003502
Prop. w/ Bachelors or Greater	-0.0477723	0.0159681	-2.9917368	0.0039564	-0.0796820	-0.0158626
Roadway Miles per 10,000 population	-0.0000884	0.0001054	-0.8389951	0.4046444	-0.0002990	0.0001222
Transit Miles per 10,000 population	0.0016960	0.0019501	0.8696781	0.3877778	-0.0022010	0.0055930

Table 9: City Population minus Housing Unit Growth Regression Results

Removing the five outliers with standardized residuals greater than 1.96 or less than -1.96 improves R^2 to 0.255. Removing outliers results in a mixed bag with respect to individual variables, with some gaining and some losing explanatory power. The independent variables, Median Age of Housing Unit and Percent of Sunshine, cross the t-stat threshold of 1.0. The changes include:

1. *Proportion of Population 25+ with Bachelors or Greater:* Regressing on the data without outliers results in a t-stat of -2.18, a degradation compared to the previous regression. Additionally, the coefficient's estimate halves to -0.21.

2. *Median Age:* The t-stat improves to -1.74 while the coefficient decreases in magnitude to -0.0005.

3. *Median Age of Housing Unit:* This variable appears with a t-stat of 1.05 and a coefficient of 8.3043×10^{-5} indicating marginal explanatory power. This may mean that cities with older buildings are less attractive to investors or smaller household cohorts such as echo boomers or empty nesters.

4. *Percent of Sunshine:* With the new regression, this independent variable crosses the t-stat threshold with a 1.48 value, indicating a 14% chance that this variable has no effect. The coefficient, however, is only 0.0001.

Table 10 on the next page details the complete results of the truncated dataset regression:

Regression Statistics	
Multiple R	0.504843894
R Square	0.254867358
Adjusted R Square	0.139243327
Standard Error	0.004841133
Observations	68

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.001505522	0.013973799	0.1077389	0.914575	-0.026466076	0.02947712
City as proportion of MSA (population)	0.001077641	0.004304093	0.2503759	0.803181	-0.007537937	0.00969322
Major River Dummy	-0.00050868	0.001282577	-0.396607	0.693112	-0.003076036	0.002058677
Median Age 2000	-0.0005318	0.00030533	-1.741734	0.086856	-0.001142986	7.93806E-05
Median Age of Housing Unit	8.30433E-05	7.8718E-05	1.0549472	0.295824	-7.45279E-05	0.000240615
Median HH Income	1.13386E-08	1.30853E-07	0.0866514	0.931247	-2.50593E-07	2.7327E-07
Percent Sunshine	0.000112826	7.60097E-05	1.4843597	0.143128	-3.93242E-05	0.000264976
Prop. w/ Bachelors or Greater	-0.02100725	0.009633889	-2.180558	0.033286	-0.040291578	-0.00172293
Roadway Miles per 10,000 population	-5.3452E-05	6.14877E-05	-0.869311	0.388261	-0.000176533	6.96291E-05
Transit Miles per 10,000 population	0.001082525	0.001150922	0.9405723	0.350825	-0.001221295	0.003386345

Table 10: City Population minus Housing Unit Growth Regression Results (with outliers removed)

First and foremost, the summary statistics confirm the previous Population vs. Housing Unit plot by showing that, by and large, the growth rate of housing units exceeds the growth rate of population. Overall, the shift in the ratio of housing units to population occurs the most in cities where there are younger, more educated people. This provides support for arguments that young professionals are moving into cities while families move out. Admittedly, while some of the disparity between population and housing unit growth could be due to investors or significant redevelopment policy initiatives, the combination of the results of the educational and median age explanatory variables gives more support to the idea that smaller young professional households are moving into the city.

Section 5.5 City Housing Unit Growth

Finally, examining where city housing unit growth occurs and how it relates to selected independent variables will allow us to tease out further conclusions from the data. Note that here, the focus is solely on city growth rates and not on the relative under/over-performance compared to the MSA. Essentially, this analysis only cares about where growth occurs fastest and not where growth occurs faster than its associated MSA.

Section 5.5.1 Dependent Variable

The dependent variable is the annualized housing unit growth rate from the period 2000 to 2004. In comparison to the previous housing unit growth measures, this city-only analysis was able to use actual housing stock counts for the baseline 2000 year.[12] First, a summary of the results of this transformation of seventy three cities is shown below in Table 11. The detailed results can be found in Appendix V.

Housing Unit Growth (City 2000-2004)	
Average	1.69%
Median	1.51%
Standard Deviation	1.34%
Maximum	5.86%
Minimum	0.12%
Positive Values	73
Negative Values	0

Table 11: City Housing Unit Growth

12 For earlier relative growth analyses, since MSA housing stock values were not available for 2000, household counts were used as baseline values for both city and MSA.

Noting that the government data only represents gross additions to stock and leaves out conversions and demolitions, housing unit growth has been positive for all sample cities. The growth rate averages 1.69%, however, has significant variation as noted by the 1.34% standard deviation. The maximum of 5.86% growth occurs in Charlotte, NC while the minimum of 0.12% occurs in Rochester, NY. Absent significant demolitions, it appears that most cities are adding housing stock.

<u>Section 5.5.2</u> Regression Results and Discussion

Regressing city housing unit growth on fifteen independent variables results in a R^2 of 0.78. Of the independent variables, seven exhibit t-stats with an absolute value greater than 1.0:

1. *City Population Growth:* As expected, city population growth correlates very well with housing unit growth. The t-stat is high at 4.43 with a coefficient of 0.54. This implies that, holding all else constant, housing units grow at roughly half the rate of population growth. This value implies that it takes fewer people to form a new household, giving further credence to the argument that empty nesters and echo boomers are driving re-urbanization.

2. *Median Age of Housing Unit:* With a t-stat of -2.56 and a coefficient of 0.0004, this variable has good significance but weak effect. The observations average 43.4 years and have a standard deviation of 12.8. The inverse relationship could potentially be because the older housing stock of slow growth cities is due to restrictive zoning regimes that has prevented past redevelopment and will likely prevent significant future development.

3. *Combined Degree Days:* The t-stat of 2.90 implies strong significance while the coefficient of 2.383×10^{-6} shows reasonable effect. The sample data has an average of 5,546 and a standard deviation of 1,527. It appears that cities with more extreme climates grow faster than cities with temperate ones, a relationship that counters earlier findings.

4. *City as Proportion of MSA:* A t-stat of -1.22 with a coefficient of -0.0089 does not imply a very strong relationship but does remain interesting. Plausibly, cities that take up a significant portion of the MSA are generally less cosmopolitan and less desirable. It would stand to reason that desirable cities would have suburban development surrounding it. So therefore this variable may be a proxy for "city desirability" and therefore higher proportion cities are less desirable and receive less attention from developers.

5. *Proportion with Bachelors or Greater:* With a t-stat of 2.28 on a coefficient of 0.056, this variable has significant explanatory power. It appears that cities with more educated population achieve stronger housing unit growth. This makes sense, given earlier results that show that cities with high educational attainment also have greater disparities between housing unit and population growth. Therefore, for every given unit increase in highly educated population, a disproportionately large amount of housing is created.

6. *Percent Sunshine:* A t-stat of 1.08 with a coefficient of 0.00015 does not imply strong explanatory power but the relationship does point in the right direction. Cities with better climate, measured by sunshine, do better in terms of housing unit growth because perhaps they attract the more educated residents.

7. *Major River Dummy:* Again, the t-stat of -1.70 and a coefficient of -0.003 implies that locating near a major river disadvantages a city in terms of housing unit growth.

The complete regression results are shown on the next page in Table 12:

Regression Statistics	
Multiple R	0.881669547
R Square	0.777341189
Adjusted R Square	0.718746766
Standard Error	0.00710869
Observations	73

Independent Variable	*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.021896723	0.051738889	-0.423215952	0.673730301	-0.125502061	0.081708615
Avg Daily Traffic Per Freeway Lane	2.97339E-07	3.87426E-07	0.767472799	0.445968047	-4.78468E-07	1.07315E-06
Average Household Size	0.000912593	0.009972860	0.091507637	0.927410077	-0.019057715	0.020882901
City as proportion of MSA (population)	-0.008855888	0.007285540	-1.215543102	0.229169675	-0.023444931	0.005733154
City Population Growth 00-04	0.543318392	0.122539588	4.433819316	4.27330E-05	0.297937101	0.788699682
Combined Degree Days	2.35826E-06	8.14428E-07	2.895599486	0.005356987	7.27394E-07	3.98912E-06
CrimeIndex	-0.000172840	0.001986040	-0.087027244	0.930954867	-0.004149815	0.003804136
LargeLake/Ocean Dummy	0.000178138	0.002304065	0.077314613	0.938644023	-0.004435672	0.004791948
Major River Dummy	-0.003260266	0.001917577	-1.700200811	0.094544123	-0.007100147	0.000579616
Median Age 2000	0.000487241	0.000586023	0.831436457	0.409196666	-0.000686250	0.001660733
Median Age of Housing Unit	-0.000385518	0.000150340	-2.564304957	0.012998049	-0.000686568	-8.44670E-05
Median Household Income	-1.65914E-07	2.15851E-07	-0.768653969	0.445271948	-5.98148E-07	2.66319E-07
Percent Sunshine	0.000149332	0.000138145	1.080979364	0.284258726	-0.000127298	0.000425962
Prop. w/ Bachelors or Greater	0.055988037	0.024540107	2.281491202	0.026273977	0.006847322	0.105128753
Roadway Miles per 10,000 population	3.85833E-05	0.000118539	0.325490054	0.746002042	-0.000198787	0.000275954
Transit Miles per 10,000 population	-0.001786544	0.001894863	-0.942835794	0.349744058	-0.005580941	0.002007853

Table 12: City Housing Unit Growth Regression Results

Removing the four outliers with standardized residuals greater than 1.96 or less than -1.96 results in a new regression where R^2 improves to 0.89. However, only two independent variables increase in explanatory power while five weaken. Of the ones that weakened, four fell below the 1.0 t-stat threshold. Additionally, one increases to cross the 1.0 t-stat threshold. Overall, while it appears that while the R^2 improved marginally with a couple of already strong variables increasing their t-stats, most variables experienced a drop in t-stat value. The changes include:

1. *Average Household Size:* T-stat increases dramatically to -1.62 with a coefficient of -0.01. This result cooperates with earlier analyses and provides further evidence that childless households are displacing families in cities with their more numerous, less dense housing units.

2. *City as Proportion of MSA:* The t-stat on this variable decreased to 0.07, dropping it below the 1.0 t-stat threshold for significance.

3. *City Population Growth:* The t-stat increases dramatically to an astonishing 8.53 and the coefficient increases to 0.675.

4. *Combined Degree Days:* For this variable, the t-stat drops to 1.42 with the coefficient also falling to 7.803×10^{-7}.

5. *Major River Dummy Variable:* The truncated regression results in a lowering of this variable's t-stat to -0.27, rending it essentially meaningless.

6. *Median Age of Housing Unit:* The t-stat increases to -2.83 while the coefficient decreases to 0.00027.

7. *Percent Sunshine:* This variable becomes meaningless with the t-stat dropping to 0.83.

8. *Proportion with Bachelor's or Greater:* This variable also loses explanatory power with the t-stat dropping to 0.62.

Table 13 on the next page details the complete results of the truncated dataset regression:

Regression Statistics	
Multiple R	0.941417
R Square	0.886266
Adjusted R Square	0.854077
Standard Error	0.004421
Observations	69

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.036182549	0.030829661	1.173627870	0.245791310	-0.025653918	0.098019016
Avg Daily Traffic Per Freeway Lane	8.49526E-08	2.50444E-07	0.339207520	0.735793816	-4.17375E-07	5.87280E-07
Average Household Size	-0.010325647	0.006355243	-1.624744732	0.110149859	-0.023072649	0.002421355
City as proportion of MSA (population)	0.000307745	0.004676105	0.065812344	0.947774854	-0.009071334	0.009686825
City Population Growth	0.675342083	0.079198210	8.527239243	1.62448E-11	0.516490594	0.834193571
Combined Degree Days	7.80255E-07	5.49142E-07	1.420862506	0.161213718	-3.21184E-07	1.88169E-06
CrimeIndex	-0.000139807	0.001235657	-0.113144143	0.910343765	-0.002618221	0.002338607
LargeLake/Ocean Dummy	0.000902644	0.001440496	0.626620110	0.533598156	-0.001986626	0.003791914
Major River Dummy	-0.000338222	0.001268941	-0.266538677	0.790858661	-0.002883395	0.002206951
Median Age 2000	4.53322E-05	0.000371608	0.121989284	0.903368876	-0.000700019	0.000790683
Median Age of Housing Unit	-0.000269429	9.51046E-05	-2.832973664	0.006508391	-0.000460184	-7.86731E-05
Median Household Income	2.66242E-08	1.36790E-07	0.194635874	0.846422187	-2.47741E-07	3.00989E-07
Percent of Sunshine	7.26277E-05	8.70430E-05	0.834388888	0.407807063	-0.000101958	0.000247214
Prop. w/ Bachelors or Greater	0.010055058	0.016045224	0.626669831	0.533565806	-0.022127586	0.042237702
Roadway Miles per 10,000 population	-2.94082E-05	7.47208E-05	-0.393575079	0.695473686	-0.000179279	0.000120463
Transit Miles per 10,000 population	-0.000461429	0.001212813	-0.380462065	0.705123068	-0.002894024	0.001971165

Table 13: City Housing Unit Growth (with outliers removed)

Overall, the city housing unit growth results confirm earlier findings. Quite obviously, housing unit growth follows population growth. Additionally it appears that bad weather helps city housing unit growth quite a bit, contradicting the results of other regressions. Combined Degree Days has a surprising positive coefficient, implying that more temperate climates will experience worse housing unit growth while Percent Sunshine has the expected positive relationship with housing unit growth. Finally, it appears that a more educated population results in greater housing unit growth, giving further credence to the belief that highly educated echo boomers, with their smaller households and therefore higher housing unit demands, are driving re-urbanization.

<u>Section 5.6</u> Housing Unit Growth vs. Property Value Growth (City minus MSA)

Plotting Housing Unit Growth against Property Value Growth for City minus MSA will allow conclusions to be drawn in regards to supply and demand of housing units. *Ceteris paribas*, one would expect one basic and predictable changes in prices and quantity supplied from shifts in either supply and demand. Of course, with the significant effect of capital market conditions and market intervention in the form of zoning, rarely do you get *all else equal* in the real world.

An initial glance at the plot reveals a shotgun pattern, if anything. The plot can be seen below as Figure 4:

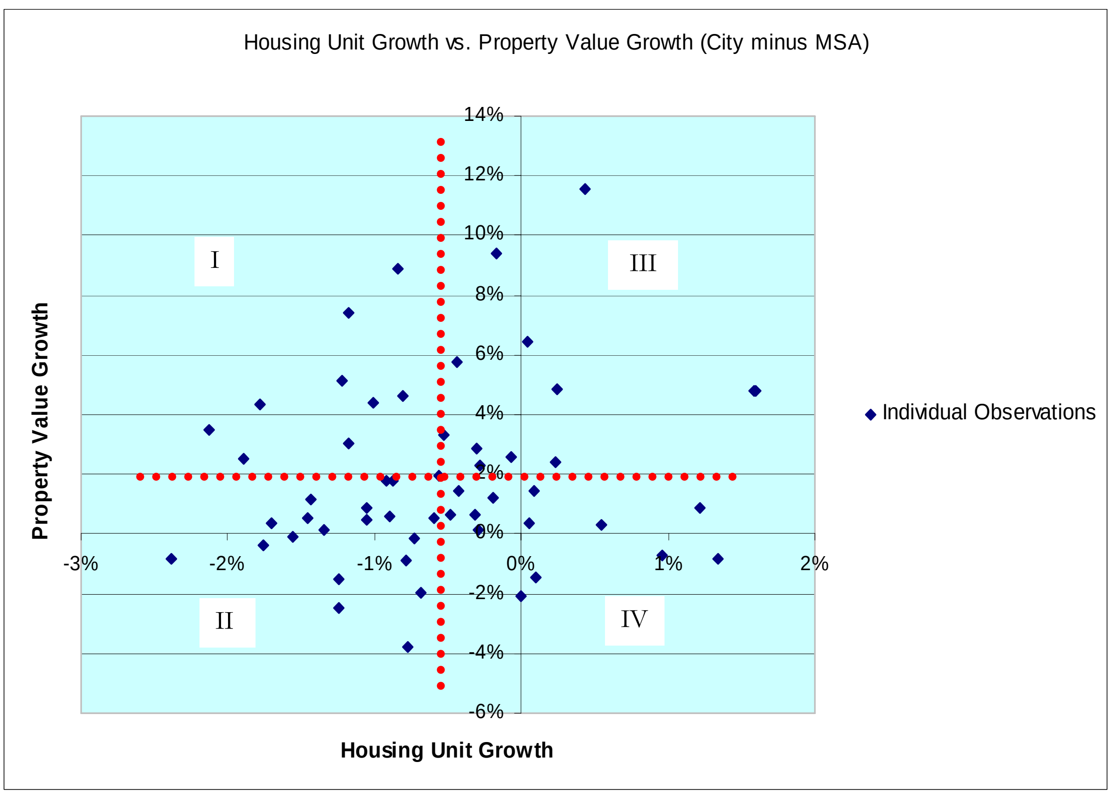

Figure 4: Housing Unit Growth vs. Property Value Growth (City minus MSA)

By drawing dotted crosshairs on the mean values for both City minus MSA Housing Unit Growth (-0.56%) and City minus MSA Property Value Growth (1.95%), the plot is divided into four quadrants, which can then be analyzed separately. First, the averages reveal that overall, the city lags the MSA in terms of housing unit growth but outperforms in terms of property value growth. Even considering the overall population loss, the cities appear to follow the laws of supply and demand with slower supply contributing to an increase in prices. Averages, however, do not tell the complete story and examination of each quadrant reveals a mixed bag of supply and demand changes. The traditional supply/demand graph shown as Figure 5 on the next page will guide our discussion of individual quadrants. The initial equilibrium point A occurs at the intersection of supply curve S1 and demand curve D1. Note that the stylized supply/demand graph shown below makes assumptions regarding elasticity and magnitude of shifts. Regardless of the actual elasticity or magnitudes, the graph helps guide the discussion that follows.

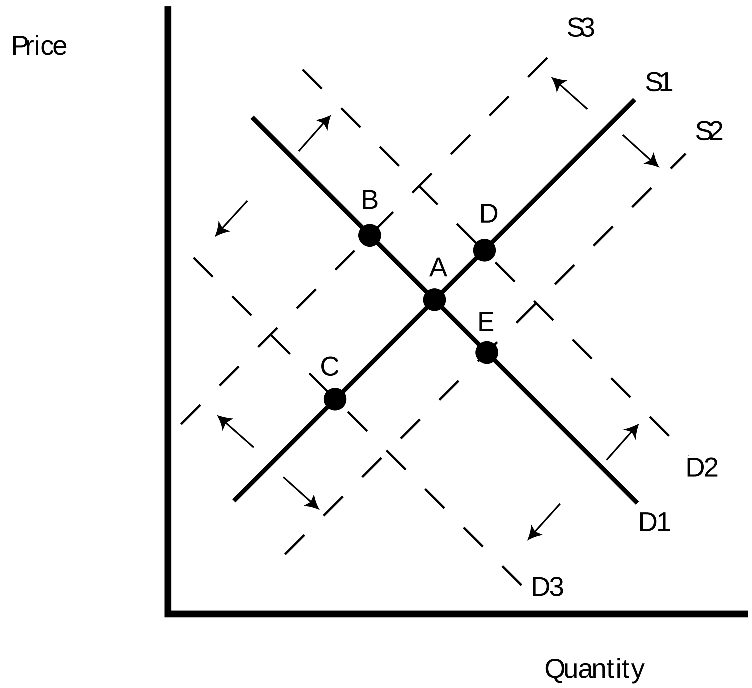

Figure 5: Stylized Supply-Demand of City Housing Units

<u>Section 5.6.1</u> Quadrant I Discussion

Cities located in Quadrant I are losing housing units relative to the MSA while at the same time outpacing the MSA in property value growth. This contraction of supply could occur due to a more laborious zoning process in the central city compared to the suburbs, a common situation in America. On Figure 5, this would be represented by a contraction from the supply curve S1 to S3 and a movement along the demand curve D1 to arrive at point B. For example, in Boston, the Article 80 process takes on average 2-3 years from initial application to building permit.[13] With such a significant delay in supply response, demand could clearly outpace supply as population moves into a new area, resulting in the

[13] Based on 10/15/05 conversations with Boston Redevelopment Authority staff.

observed increase in property values without corresponding stock increases. Coincidentally, heavy development regulation also leads to overbuilding since the lag on expansion of supply also applies to contraction of supply (Wheaton, 1995).

Section 5.6.2 Quadrant II Discussion

In terms of competing against their MSAs, cities located in Quadrant II have done the worst. For points in Quadrant II that fall below the mean property value growth line, demand has fallen which resulted in relative property value growth lagging. As a result, developers have chosen to focus on the surrounding areas rather than the central city, resulting in the underperformance of housing unit growth. This housing unit underperformance could be due both developer focus on the surrounding areas and general neglect of buildings in the central city, which could possibly result in their being taken off the market if price falls so low that net operating income is negative. On Figure 5, this appears as a shift of demand curve D1 to D3 and movement along S1, resulting in an equilibrium of point C.

The majority of cities in this quadrant experience relative housing unit underperformance while property values continue to slight outpace the MSA. Overall, the large number of cities falling in Quadrant II appears to indicate that cities are continuing to underperform their MSAs in terms of demand and therefore suffer less than average property value growth performance.

Section 5.6.3 Quadrant III Discussion

In contrast to cities in Quadrant II, cities falling in Quadrant III are winners compared to their MSA. Here, cities have experienced significant development activity and price growth that outpaces the MSA. These cities experienced strong demand and the resulting price increases caused developers to respond by building more units now that property values were above construction costs. In Figure 5, demand curve D1 shifts outwards to D2, there is movement along the supply curve and the market equilibrates at point D. The source of demand, however, cannot be determined and this analysis does not make clear whether the demand stems from growth in occupied units demanded or growth in investment/second homes. Irrespective of the source of demand, only five cities fall within this "winner's quadrant".

Section 5.6.4 Quadrant IV Discussion

Finally, Quadrant IV exhibits supply-based changes. Housing unit growth outpaces the MSA but property values increased less than the mean, indicating that prices had to come down for absorption to occur. On Figure 5, supply curve S1 expands to S2 with no shifts in demand, but rather movement along the demand curve with the cities equilibrating on point E.

This shift most likely has to do with land use policy. Supply expansions can occur due to strong redevelopment programs initiated by a progressive planning board that attempts, through either restrictions or enticement, to direct development to the central city. Restrictions on office/retail development or tax abatements on residential developments are both examples of how housing unit supply can increase dramatically. However, the weak property value growth implies that developers overshot demand and had to reduce prices to ensure absorption.

As can be seen from this analysis, averages do not tell the whole story. Demand and supply have contracted and expanded in various combinations and produced various new equilibrium results. Examination of the quadrants reveals that the hyper-growth stories are few and far between while the largest group experiences lags in housing unit growth along with outpaced property value growth. This fits nicely with the notion that while people want to be in the city (either through occupying units or investment), the more restrictive nature of city zoning combined with a lack of open land conspires to restrict development. The quadrants and their constituent cities can be found in Appendix IV.

<u>Section 5.7</u> City minus MSA Housing Unit Growth by Quadrants

Dividing the cities into two groups allows us to draw conclusions based on supply and demand shifts. Looking at quadrants I & IV will focus on changes due to supply shifts while quadrants II & III focus on demand shifts. The dependent and independent variables are the same as those in Section 5.2, except the sample cities are split into the aforementioned groups. Tables 14 and 15 below detail the summary statistics for the sample data.

Quadrants I & IV Housing Unit Growth (City – MSA annualized)

Average	-0.43%
Median	-0.37%
Standard Deviation	0.95%
Maximum	1.34%
Minimum	-2.13%
Positive Values	7
Negative Values	15

Table 14: Housing Unit Growth Over/Under Performance Summary (Quadrants I & IV)

Quadrants II & III Housing Unit Growth (City – MSA annualized)

Average	-0.65%
Median	-0.77%
Standard Deviation	0.88%
Maximum	1.60%
Minimum	-2.38%
Positive Values	6
Negative Values	25

Table 15: Housing Unit Growth Over/Under Performance Summary (Quadrants II & III)

In general, the summary statistics are similar except that II & III quadrants show lesser values for all of the measures of central tendency.

Section 5.7.1 Regression Results and Discussion

Regressing relative city/MSA housing unit growth on the same twelve independent variables results in a R^2 of 0.82 for quadrants I & IV and a R^2 of 0.64 for quadrants II & III. Below is a discussion of notable differences between the two regression results:

1. *Large Lake/Ocean Dummy:*
    a. On the supply side (I & IV) being close to a large body of water has a t-stat of 1.45 with a coefficient of 0.0055, indicating that for whatever reason developers like to build near these water amenities. Potentially, developers and/or city planners believe that proximity to this amenity should be reason for development to occur. Potentially it could also be that cities located next to these bodies of water have converted their traditionally waterfront industrial uses to more contemporary housing uses.
    b. In contrast, the demand side (II & III) shows that being close to the same amenity has a t-stat of -1.01 and a coefficient of -0.005, indicating that on the demand side, it is not desirable.

2. *Major River Dummy:*
    a. On the supply side (I & IV) being close to a major river does not create discernable effect on relative housing unit growth.
    b. On the demand side (II & III), however, the t-stat is -3.13 with a coefficient of -0.013. This direction matches the result for the previous variable. So again, it appears that it is not desirable from a demand point of view to be near a major water amenity.

3. *Median Age of Housing Unit:* This variable only shows significance on the demand side (II & III) with a strong t-stat of -2.75 and a coefficient of -0.0006. It appears that older housing units do not increase demand for the central city.

4. *Combined Degree Days:* Oddly, this variable has a t-stat of 2.66 and a 4.123×10^{-6}, indicating that cities that are more inclement weather-wise have positive supply-side effects. The variable has a slightly positive effect on quadrants II & III, with a t-stat of 1.09 and a coefficient of 1.340×10^{-6}. This result runs counter to the directionality of the coefficient in both relative population and relative property value growth.

5. *Roadway Miles per 10,000 population:* On the quadrant II & III regressions, this variable has a t-stat of -2.84 and a coefficient of -0.0007 indicating that having lots of roads appears to not induce people to desire central city housing units. This variable has no discernable effect on the quadrant I & IV regression.

6. *Average Daily Traffic per Freeway Lane Mile :* This variable has a stronger effect on quadrant I & III cities with a t-stat of -3.23 and a coefficient of 1.831×10^{-6} while having a weaker effect on quadrant II & IV cities. This coincides with earlier results from relative population growth regressions.

7. *Average Household Size:* This variable has positive relationships with both regressions but a stronger relationship with quadrant II & III cities, where the t-stat is 2.27 on a coefficient of 0.40. Assuming the earlier conjecture regarding large families getting displaced is true, it appears that it is more accurate from a demand led standpoint than a supply led one.

8. *Median Age:* Again, here the coefficient is stronger for the quadrant II & III cities, with a t-stat of 2.38 on a coefficient of 0.003. The values for the other regression are similar but not as powerful (2.24, 0.002).

9. *Crime Index:* Finally, our counterintuitive crime results again show the same positive directionality. The t-stat of 2.21 and coefficient of 0.018 for quadrant II & III best the t-stat of 1.01 and coefficient of 0.006 for the other regression. It appears that

the push into crime ridden cities comes from the demand side rather than supply side.

The complete regression results are shown on the following pages in Table 16 and 17:

Regression Statistics	
Multiple R	0.907331682
R Square	0.82325078
Adjusted R Square	0.587585154
Standard Error	0.006108199
Observations	22

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.115516379	0.078317261	-1.474979821	0.174320307	-0.292682331	0.061649573
Average Daily Traffic Per FLM	-9.20903E-07	7.93933E-07	-1.159925277	0.275924152	-2.71690E-06	8.75098E-07
Average Household Size	0.028017187	0.017001727	1.647902359	0.133775866	-0.010443393	0.066477766
City as proportion of MSA (Population)	-0.000858132	0.012259336	-0.069998266	0.945725702	-0.028590677	0.026874412
Combined Degree Days	4.12262E-06	1.54813E-06	2.662970334	0.025919317	6.20510E-07	7.62472E-06
Crime Index	0.006016930	0.005980978	1.006011054	0.340690038	-0.007512982	0.019546841
LargeLake/Ocean Dummy	0.005516781	0.003818065	1.444915455	0.182382001	-0.003120282	0.014153844
Major River Dummy	0.000578452	0.003133937	0.184576867	0.857653076	-0.006511006	0.007667910
Median Age	0.001714422	0.000763875	2.244373228	0.051474255	-1.35847E-05	0.003442428
Median Age of Housing Unit	-0.000632076	0.000229543	-2.753623386	0.022343984	-0.001151340	-0.000112813
Median HH Income	-9.38688E-07	4.50961E-07	-2.081527938	0.067098783	-1.95883E-06	8.14568E-08
Prop. w/ Bachelors or Greater	0.125153288	0.045897485	2.726800591	0.023346474	0.021325965	0.228980611
Roadway Miles per 10,000 population	-0.000160245	0.000224093	-0.715081699	0.492690023	-0.000667178	0.000346688

Table 16: City minus MSA Housing Unit Growth (Quadrants I & IV)

Regression Statistics	
Multiple R	0.798286461
R Square	0.637261273
Adjusted R Square	0.395435455
Standard Error	0.006853944
Observations	31

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.181074002	0.085004485	-2.130169989	0.04720815	-0.359661798	-0.002486207
Average Daily Traffic Per FLM	-1.83053E-06	5.66951E-07	-3.228732915	0.004658548	-3.02166E-06	-6.39414E-07
Average Household Size	0.039981351	0.017639366	2.266597981	0.035974028	0.002922419	0.077040284
City as proportion of MSA (Population)	0.008656405	0.017207952	0.503046808	0.621031086	-0.027496161	0.044808972
Combined Degree Days	1.34013E-06	1.23267E-06	1.087176162	0.291303307	-1.24962E-06	3.92988E-06
Crime Index	0.017674515	0.008003714	2.208289233	0.040434665	0.000859336	0.034489693
LargeLake/Ocean Dummy	-0.004674224	0.004609752	-1.013985851	0.324026347	-0.014358954	0.005010507
Major River Dummy	-0.012560599	0.004013598	-3.129511055	0.005792737	-0.020992855	-0.004128343
Median Age	0.003162227	0.001331120	2.375614390	0.028832193	0.000365648	0.005958805
Median Age of Housing Unit	-0.000135557	0.000160387	-0.845186508	0.409101186	-0.000472518	0.000201404
Median HH Income	-8.87184E-07	4.14929E-07	-2.138159264	0.046470643	-1.75892E-06	-1.54508E-08
Prop. w/ Bachelors or Greater	0.140982074	0.049187276	2.866230544	0.010266653	0.037643441	0.244320707
Roadway Miles per 10,000 population	-0.000701068	0.000246510	-2.843973209	0.010770472	-0.001218966	-0.000183169

Table 17: City minus MSA Housing Unit Growth (Quadrants II & III)

Because of the small sample size associated with these two regressions, outliers were not removed. Parsing the sample cities into groups based on their proposed supply and demand driven housing unit growth and regressing these groups allows for interesting observations. It appears that generally speaking, the growth variations are demand driven. People move away from cities in areas with dense roadway networks and developers follow them rather than the other way around. Only the Median Age of HU effects appear to be supply driven.

<u>Section 5.8</u> Property Value Growth (City minus MSA)

Property Value Growth Hypothesis – The hypotheses for relative city property value growth mirrors the population and housing unit growth predictions. Educational attainment should be positively correlated with relative property value growth while crime rate will have the opposite relationship. For environmental variables, combined degree days, a proxy for climatic adversity, will have a negative relationship while proximity to water amenities should be positively correlated to relative property value growth. And finally, for transportation variables, I expect property value growth to occur most strongly where difficult inter-city travel combines with efficient intra-city travel. Again, that implies that transit miles will trend in the same direction as property value growth while roadway miles will exhibit a negative correlation.

<u>Section 5.8.1</u> Dependent Variable Transformation

By subtracting MSA property value growth from city property value growth, the resulting dependent variable represents the over/under performance of a city's property value growth rate with its associated MSA. Holding supply growth at historical levels, this would essentially measure whether demand favors the city or the MSA. While MSA property value growth came from the National Association of Realtors and therefore included all seventy three sample cities, the city property value growth data came from Zillow.com and only included fifty three cities. Therefore, the sample size in this regression has been reduced by twenty observations. First, a summary of the results of this transformation of fifty three city/MSA pairs are shown below in Table 18. The detailed results can be found in Appendix V.

Property Value Growth (City minus MSA 2000-2004)	
Average	1.95%
Median	1.18%
Standard Deviation	3.11%
Maximum	11.54%
Minimum	-3.77%
Positive Values	40
Negative Values	13

Table 18: Property Value Growth (City minus MSA)

With property value growth, at least in terms of residential property, the average central city performance outpaces the overall MSA. Performance varies considerably with a standard deviation of 3.11% on an average of 1.95% and a range of nearly 15%. However, 75% of cities outperform their MSAs, allowing us to reliably conclude that demand for housing units outpaces the supply in cities. The maximum value occurs in Albuquerque, NM with 11.54% relative city property value growth while Kansas City, MO lags its MSA by 3.77%. Absent a significant investor pool, it appears that demand for city residences is strong.

Section 5.8.2 Regression Results and Discussion

Regressing relative city/MSA property value growth on the eleven independent variables results in a R^2 of 0.22. Of the independent variables, only three exhibit t-stats with an absolute value greater than 1.0:

1. *Combined Degree Days:* A t-stat of -1.35 and a coefficient of -5.025×10^{-6} confirms the hypothesis. Intuitively this makes sense as demand for properties in cities with harsher climates may lag those in more temperate areas. The decreased reliance on vehicle travel in cities matches better to more temperate climates. This confirms the hypothesis that adverse conditions result in lower relative city property value growth.

2. *Crime Index:* With a t-stat of 1.894, this demographic statistic has significant explanatory power. The coefficient of 0.034 combined with the high t-stat implies that this variable has significant and stronger effects on property value growth. This does not appear to make sense as there should not be a positive correlation between crime and property value growth and therefore rejects our hypothesis. However, potentially areas with significant crime have had property values depressed for so long that with the recent increased appetite for all things real estate, these formerly derelict areas have become attractive. Perhaps a third unspecified variable such as population density has strong correlation to both Crime Index and property value growth. Given the variables chosen, it appears that crime positively correlates with increases in property value.

3. *Percent Sunshine:* The marginal t-stat of 1.10 with the coefficient of 0.0007 implies weak explanatory power. However, the direction of correlation matches the hypothesis. Plausibly, cities with more walking-friendly weather might have more demand than their MSAs.

The complete regression results are shown on the next page in Table 19:

Regression Statistics	
Multiple R	0.466326
R Square	0.21746
Adjusted R Square	0.00751
Standard Error	0.03099
Observations	53

Independent Variable	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.069938858	0.090687798	-0.771204724	0.445007601	-0.25308658	0.113208863
City as proportion of MSA (population)	0.03167284	0.034535863	0.917099995	0.364453628	-0.038073749	0.101419429
Combined Degree Days	-5.02561E-06	3.73487E-06	-1.345590274	0.185829323	-1.25683E-05	2.51712E-06
CrimeIndex	0.033951387	0.017922272	1.894368467	0.065244644	-0.002243375	0.07014615
LargeLake/Ocean Dummy	-0.005909058	0.012533449	-0.47146304	0.639809375	-0.031220873	0.019402756
Major River Dummy	-0.009974428	0.010244563	-0.973631439	0.335949153	-0.030663742	0.010714885
Median Age of Housing Unit	0.000103152	0.000585235	0.17625838	0.860958703	-0.001078753	0.001285058
Median HH Income	2.70189E-07	1.02825E-06	0.262765192	0.794047495	-1.80641E-06	2.34678E-06
Percent Sunshine	0.000684387	0.000623927	1.096903516	0.279084475	-0.000575658	0.001944433
Prop. w/ Bachelors or Greater	0.009106434	0.076852336	0.118492616	0.906255995	-0.146100005	0.164312874
Roadway Miles per 10,000 population	-9.17471E-05	0.000579475	-0.158327995	0.874975623	-0.00126202	0.001078526
Transit Miles per 10,000 population	0.008715623	0.008856528	0.984090337	0.33084302	-0.009170497	0.026601743

Table 19: City minus MSA Property Value Growth Regression Results

Removing the two outliers with standardized residuals greater than 1.96 or less than -1.96 results in a new regression where R^2 improves to 0.38. The explanatory power of Combined Degree Days strengthens while the Crime Index and Percent Sunshine variables weaken. Two more variables cross the t-stat threshold of 1.0. The changes include:

1. *Crime Index:* T-stat decreases marginally to 1.887 with a decrease in magnitude to 0.026.

2. *Combined Degree Days:* The t-stat on this environmental variable increases to -2.45 with a coefficient of -7.283×10^{-6}. The sample combined degree days data averages 5,522 with a standard deviation of 1,536 indicating that a city with one standard deviation below the mean in terms of combined degree days would experience 1.12% more relative growth compared to its MSA than a city with the mean combined degree days.

3. *Transit Miles per 10,000 Population:* The t-stat of 2.04 and coefficient of 0.014 implies that cities with more transit experience higher relative growth compared to cities with less transit. This provides support to the hypothesis that people want to live in cities with easier intra-city transportation options.

4. *Large Lake / Ocean Dummy Variable:* A t-stat of -1.51 implies moderate explanatory power and a coefficient of -0.015 indicates strong effect. This result runs contrary to the stated hypothesis. It appears that proximity to this water amenity results in decreased central city relative property value growth. Potentially, because of the very limited supply of waterfront city parcels, residents prefer to live outside of the city and be close to the water amenity without having to compete for the limited city waterfront. Additionally, this industrial-laden waterfront may contribute to overall city property value growth underperformance.

5. *Percent Sunshine:* The truncated regression results in a lowering of this t-stat to 0.37, rending it essentially meaningless.

Table 20 on the next page details the complete results of the truncated dataset regression:

Regression Statistics	
Multiple R	0.613330351
R Square	0.376174119
Adjusted R Square	0.20022323
Standard Error	0.023906961
Observations	51

Independent Variable	***Coefficients***	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	0.003397577	0.071246849	0.047687399	0.962208749	-0.140712777	0.147507931
City as proportion of MSA (population)	0.012037121	0.027072919	0.444618508	0.659053210	-0.042723025	0.066797267
Combined Degree Days	-7.28261E-06	2.96769E-06	-2.453964373	0.018698722	-1.32853E-05	-1.27989E-06
CrimeIndex	0.026350627	0.013963973	1.887043599	0.066614015	-0.001894175	0.054595429
LargeLake/Ocean Dummy	-0.015032077	0.009948260	-1.511025775	0.138842857	-0.035154332	0.005090178
Major River Dummy	-0.007178364	0.008668715	-0.828077143	0.412665672	-0.024712495	0.010355766
Median Age of Housing Unit	-0.000169904	0.000457326	-0.371516910	0.712263396	-0.001094933	0.000755124
Median HH Income	4.48265E-07	7.96240E-07	0.562978033	0.576672274	-1.16228E-06	2.05881E-06
Percent Sunshine	0.000179992	0.000491484	0.366221557	0.716179011	-0.000814128	0.001174112
Prop. w/ Bachelors or Greater	-0.038056727	0.060024784	-0.634016894	0.529771195	-0.159468310	0.083354857
Roadway Miles per 10,000 population	-5.32571E-05	0.000449528	-0.118473440	0.906300660	-0.000962513	0.000855998
Transit Miles per 10,000 population	0.014564123	0.007123971	2.044382617	0.047708523	0.000154531	0.028973715

Table 20: City minus MSA Property Value Growth Regression Results (with outliers removed)

The relative city property value growth regression results confirm some hypothesis while rejecting others. Specifically, Combined Degree Days was confirmed to be negatively correlated to relative city growth performance while Transit Miles was positively correlated to the outcome variable. Incorrect predictions were made for Crime Index, which had a positive correlation to relative city property value growth and Lake Lake/Ocean Dummy Variable, which had a negative correlation to the dependent variable. Interestingly, many of the predicted explanatory variables had no discernable effect on the dependent variable. These included Proportion with Bachelor's or Greater, Major River Dummy Variable and Roadway Miles. Finally, the low R^2 means that the chosen variables have made the model lack explanatory power. Therefore, potentially other unknown factors may have much better correlation to the dependent variable.

VI. CONCLUSION AND FURTHER RESEARCH

Scholars and laymen alike have been writing about reversal of suburban sprawl for some time now. Led by The Brookings Institution, researchers have analyzed Census data and performed surveys and all agree on one thing: the ascendancy of the central city is demographically and geographically heterogeneous but the mass exodus started after World War II is showing nascent signs of reversal. Expectations for the future, from the point of view of city officials, include robust population growth, often at rates exceeding the MSA.

This thesis sought to add to that body of knowledge by first examining the extent and distribution of the central city's population, housing unit and property price growth compared to its MSA for the period of 2000-2004. More importantly, it examined the statistical relationship between each relative growth metric and explanatory variables grouped into three types: (1) Demographic Characteristics (2) Environmental Characteristics and (3) Transportation Statistics. The sample, by including seventy three geographically, demographically and environmentally diverse cities provided a more representative cross-section than previous studies.

On average, cities lag their MSAs in terms of population and housing unit growth while outperforming on property value growth. In the City Housing Unit Growth regression, the coefficient on City Population Growth (as independent) shows that the future growth comes from average household sizes that are smaller than the current average, providing further support for the idea that echo boomers and empty nesters are driving re-urbanization. Additionally, it is important to note that, at least in cities, population growth lags housing unit growth in virtually all sample cities, as seen in the City Housing Unit Growth vs. City Population Growth plot (Figure 3). On the surface, it appears that this combination implies irrational price increases amidst falling demand. However, a deeper look reveals two possible explanations: (1) Decreased household size (2) Increased 2nd home or investor purchases in the central city. While the former would imply that demand still exists despite population loss, the latter implies unstable demand that may disappear if investors flee real estate as an asset class. Additionally these price increases might imply that household size shrinkage exceeds the shrinkage implied by the disparity between HU and population growth. Or more pessimistically, the low cost of capital in the first five years of this millennium might have contributed to irrational demand, price increases and the corresponding developer response of adding more supply. Comparing housing unit to population growth in cities reveals that as housing unit growth accelerates, the population growth lag becomes ever larger. Save significant reductions in household size in these rapidly developing cities, this result possibly indicates that investor demand fuels cities with very high housing unit growth. Further research on the relative contribution from household shrinkage and real estate investors/speculators should be done to determine the strength of demand.

The coefficient on the independent variables matched the hypotheses in some instances and provided surprises in others. Difficult inter-city travel combined with easier intra-city travel correlated positively with the central city trumping the MSA for population, housing units and property value growth. The transportation variables did not affect the dependent variables equally. For example, Traffic per Freeway Lane Mile had the expected negative correlation with relative population growth but an even stronger negative correlation with relative housing unit growth. On the other hand Roadway Miles exhibited the expected negative relationship but had a stronger correlation to relative housing unit growth.

The transportation results imply that residents in cities that are spread out in terms of road and highway construction prefer the suburbs more than the central city. This makes intuitive sense, because as stated earlier it implies easy inter-city transportation. However, interestingly, Average Daily Traffic per Freeway Lane Mile is negative for both housing unit and population growth. It appears that heavy traffic is merely a symptom of a spread out city and does not induce people to move back into the central city. Perhaps we have not reached the tipping point yet. By looking at Average Traffic per Freeway Lane Mile and Freeway Lane Miles per 10,000 population, we can tease out interesting observations. In cities such as Atlanta, GA (19,569 Traffic and 6.34 FLM) there is a lot of traffic despite the abundance of freeways. There, as more freeways are added, people simply move outwards and absorb the new capacity. In Chicago (20,113 Traffic and 3.48 FLM) it appears that there is dense traffic yet a relatively sparse highway network. In the second most highway dense city, Tulsa, OK, there is very little traffic (9,386 Traffic and 13.22 FLM). Further study should be done on how highway expansion affects suburbanization.

In terms of who is moving to the central city, the strong positive correlation between educational achievement and relative housing unit growth combined with the negative correlation between median age and the dependent variable, population minus housing units, gives support to the argument that young, educated people contribute significantly to central city growth. However, this support, specifically the age-related coefficient, is not strong and further study to determine the relative contribution of echo boomers and empty nesters to re-urbanization is desirable.

Most interestingly, environmental variables often ran counter to expectations with one exception. Matching the hypothesis, Combined Degree Days was negatively correlated with relative property value growth, indicating that cities in better climates do better than their MSAs in terms of property value growth than cities with adverse weather. On the other hand, proximity to a water amenity appears to have the opposite relationship. For property value growth, being close to a large lake or ocean has negative correlation to relative city property value growth while being close to a river negatively correlates to housing unit growth. It appears that either these amenities are not as attractive as expected or that builders and residents prefer living near the amenities, as long as they are not located in the central city. And finally, the demographic characteristic, Crime Index was surprisingly positively correlated to relative city property value growth.

Future researchers may wish to examine how much entitlement-process related delays have affected relative city property value and relative city housing unit growth rates. The artificial constraints placed on supply may be responsible for many effects observed in this study. Additionally, further independent variables with low multicollinearity should be formulated and regressed against this study's dependent variables in an attempt to discover more unknown mechanisms.

Overall, it appears that summary statistics do not accurately represent the situation because such heterogeneity exists in the individual results. The predictions of re-urbanization have some supporting evidence but it appears too early to claim that urban sprawl has reversed.

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Appendix I: Complete List of Initial Independent Variables (2000-2004 Annualized)

Demographic Characteristics

Independent Variable	Source
2 Person Family HH to Total HH	Census 2000
Average Work Week Hours 16-64 years old	Census 2000
Central / Suburb Per Capita Income	Census 2000
City as Proportion of MSA (Population)	Census 2000
Crime Index	FBI Crime Data
HH with Self-Employed Income	Census 2000
Householder living alone proportion	Census 2000
Married Household proportion	Census 2000
Median Age of HU	Census 2000
Median Age of Population	Census 2000
Median HH Income	Census 2000
Median Household Size	Census 2000
Median Income for 16+ year old workers	Census 2000
Non-Family Ratio to Total	Census 2000
Per Capita Income	Census 2000
Proportion of HH with population 60+	Census 2000
Proportion of 25+ year olds with Bachelor's or Greater	Census 2000

Appendix I continued

Environmental Characteristics

Independent Variable	Source
Combined Degree Days	National Climatic Data Center
Cooling Degree Days	National Climatic Data Center
Heating Degree Days	National Climatic Data Center
LargeLake/Ocean Dummy	Google Maps
Major River Dummy	Google Maps
Percent Sunshine	National Climatic Data Center

Transportation Statistics

Independent Variable	Source
Average Daily Traffic Per Freeway Lane Mile	Federal Highway Administration - Highway Statistics 2004
Average Travel Time for those not working at home	Census
Freeway Lane Miles per 10,000 population	Federal Highway Administration - Highway Statistics 2004
Roadway Miles per 10,000 population	Federal Highway Administration - Highway Statistics 2004
Transit Miles per 10,000 population	National Transit Database Report

Appendix II: City minus MSA Performance Metrics (2000-2004 Annualized)

Geography	Population Growth	Housing Unit Growth
Akron, OH	-0.80%	-0.79%
Albuquerque, NM	0.28%	0.43%
Anchorage, AK	-0.65%	0.23%
Atlanta, GA	-2.22%	-0.08%
Austin, TX	-1.78%	-1.44%
Bakersfield, CA	0.96%	1.60%
Baltimore, MD	-1.36%	-1.17%
Baton Rouge, LA	-1.16%	-1.07%
Birmingham, AL	-1.69%	-1.23%
Boston, MA	-0.98%	-0.43%
Buffalo, NY	-0.54%	-0.57%
Charlotte, NC	0.00%	1.58%
Chicago, IL	-1.02%	-0.89%
Cincinnati, OH	-1.85%	-1.55%
Cleveland, OH	-0.93%	-0.73%
Colorado Springs, CO	-0.99%	1.34%
Columbus, OH	-0.48%	-0.31%
Dallas, TX	-1.83%	-1.71%
Denver, CO	-1.37%	-1.24%
Des Moines, IA	-2.01%	-2.10%
Detroit, MI	-1.55%	-1.24%
El Paso, TX	0.09%	0.09%
Fort Wayne, IN	0.91%	-1.39%
Fresno, CA	-0.25%	-0.53%
Grand Rapids, MI	-1.15%	-1.34%
Greensboro, NC	0.00%	-0.07%
Honolulu, HI	-0.31%	1.22%
Houston, TX	-1.46%	-1.45%
Indianapolis, IN	-1.35%	-1.26%
Jacksonville, FL	-0.74%	-0.81%
Kansas City, MO	-0.93%	-0.77%
Las Vegas, NV	-1.49%	-2.38%
Lexington-Fayette, KY	-0.40%	-0.28%
Lincoln, NE	0.19%	0.05%
Los Angeles, CA	-0.02%	-0.17%
Lubbock, TX	0.28%	0.49%
Madison, WI	0.09%	-0.16%
Memphis, TN	-0.04%	-0.30%
Miami, FL	-0.43%	0.55%

Appendix II continued

Geography	Population Growth	Housing Unit Growth
Milwaukee, WI	-0.79%	-0.88%
Minneapolis, MN	-1.67%	-1.76%
Mobile, AL	-0.82%	-1.04%
Montgomery, AL	-0.68%	-0.08%
Nashville-Davidson, TN	-1.40%	-1.05%
New Orleans, LA	-1.26%	-0.81%
New York, NY	-0.16%	-0.69%
Oklahoma City, OK	0.03%	0.09%
Omaha, NE	0.13%	-0.19%
Philadelphia, PA	-1.27%	-0.83%
Phoenix, AZ	-1.36%	-2.13%
Pittsburgh, PA	-0.63%	-0.60%
Portland, OR	-1.38%	-1.01%
Raleigh, NC	1.09%	0.96%
Richmond, VA	-1.89%	-1.89%
Riverside, CA	-0.63%	-1.78%
Rochester, NY	-0.92%	-0.84%
Sacramento, CA	0.07%	-0.31%
San Antonio, TX	0.03%	-0.01%
San Diego, CA	-0.11%	-0.28%
San Francisco, CA	-1.14%	-0.43%
San Jose, CA	0.23%	0.25%
Seattle, WA	-0.57%	-0.48%
Shreveport, LA	-0.55%	-0.48%
Spokane, WA	-0.86%	-0.87%
St. Louis, MO	-0.92%	-1.18%
Stockton, CA	0.18%	0.04%
Tampa, FL	-0.35%	-0.30%
Toledo, OH	-0.67%	-1.05%
Tucson, AZ	-0.41%	-0.92%
Tulsa, OK	-1.19%	-1.05%
Virginia Beach, VA	-0.16%	-0.41%
Washington, DC	-2.41%	-1.82%
Wichita, KS	0.78%	-0.38%

<u>Appendix III:</u> City Performance Metrics (2000-2004 Annualized)

Geography	Population Growth	Housing Unit Growth	Population minus HU
Akron, OH	-0.57%	0.58%	-1.14%
Albuquerque, NM	1.93%	3.25%	-1.32%
Anchorage, AK	1.17%	2.37%	-1.20%
Atlanta, GA	0.16%	4.95%	-4.80%
Austin, TX	0.95%	2.97%	-2.02%
Bakersfield, CA	3.54%	4.31%	-0.77%
Baltimore, MD	-0.58%	0.21%	-0.79%
Baton Rouge, LA	-0.41%	1.01%	-1.42%
Birmingham, AL	-1.01%	0.55%	-1.57%
Boston, MA	-0.86%	0.50%	-1.36%
Buffalo, NY	-0.85%	0.16%	-1.01%
Charlotte, NC	2.39%	6.23%	-3.85%
Chicago, IL	-0.29%	0.84%	-1.13%
Cincinnati, OH	-1.32%	0.43%	-1.75%
Cleveland, OH	-1.05%	0.28%	-1.32%
Colorado Springs, CO	0.58%	5.22%	-4.63%
Columbus, OH	0.65%	2.60%	-1.96%
Dallas, TX	0.46%	1.50%	-1.04%
Denver, CO	0.10%	2.01%	-1.92%
Des Moines, IA	-0.57%	0.79%	-1.36%
Detroit, MI	-1.37%	0.16%	-1.53%
El Paso, TX	1.24%	2.34%	-1.10%
Fort Wayne, IN	1.62%	0.68%	0.93%
Fresno, CA	1.71%	1.72%	0.00%
Grand Rapids, MI	-0.34%	0.58%	-0.92%
Greensboro, NC	0.84%	2.53%	-1.69%
Honolulu, HI	0.37%	2.43%	-2.06%
Houston, TX	0.75%	1.90%	-1.15%
Indianapolis, IN	0.08%	1.93%	-1.85%
Jacksonville, FL	1.40%	3.14%	-1.74%
Kansas City, MO	0.16%	1.64%	-1.48%
Las Vegas, NV	2.83%	4.46%	-1.64%
Lexington-Fayette, KY	0.56%	2.64%	-2.08%
Lincoln, NE	1.15%	2.51%	-1.36%
Los Angeles, CA	1.00%	0.74%	0.26%
Lubbock, TX	1.02%	3.33%	-2.30%
Madison, WI	1.44%	2.93%	-1.49%
Memphis, TN	0.83%	2.25%	-1.42%
Miami, FL	1.17%	3.01%	-1.84%

Appendix III continued

Geography	Population Growth	Housing Unit Growth	Population minus HU
Milwaukee, WI	-0.56%	0.37%	-0.93%
Minneapolis, MN	-0.57%	0.90%	-1.47%
Mobile, AL	-0.78%	0.63%	-1.41%
Montgomery, AL	-0.07%	1.47%	-1.54%
Nashville-Davidson, TN	0.05%	1.96%	-1.90%
New Orleans, LA	-1.18%	0.49%	-1.67%
New York, NY	0.30%	0.22%	0.08%
Oklahoma City, OK	1.07%	2.07%	-1.00%
Omaha, NE	1.22%	2.24%	-1.01%
Philadelphia, PA	-0.79%	0.31%	-1.10%
Phoenix, AZ	1.79%	2.85%	-1.06%
Pittsburgh, PA	-0.92%	0.24%	-1.16%
Portland, OR	0.21%	1.34%	-1.14%
Raleigh, NC	4.29%	5.94%	-1.65%
Richmond, VA	-0.68%	0.58%	-1.25%
Riverside, CA	3.11%	2.17%	0.94%
Rochester, NY	-0.84%	0.13%	-0.97%
Sacramento, CA	2.79%	3.29%	-0.50%
San Antonio, TX	1.94%	2.70%	-0.76%
San Diego, CA	0.81%	1.62%	-0.81%
San Francisco, CA	-1.06%	0.65%	-1.71%
San Jose, CA	0.27%	1.54%	-1.27%
Seattle, WA	0.36%	1.73%	-1.38%
Shreveport, LA	-0.18%	0.81%	-1.00%
Spokane, WA	0.14%	1.06%	-0.92%
St. Louis, MO	-0.35%	0.43%	-0.78%
Stockton, CA	3.51%	3.84%	-0.33%
Tampa, FL	1.48%	2.61%	-1.14%
Toledo, OH	-0.70%	0.39%	-1.09%
Tucson, AZ	1.28%	2.00%	-0.72%
Tulsa, OK	-0.60%	0.52%	-1.11%
Virginia Beach, VA	0.86%	1.55%	-0.69%
Washington, DC	-0.82%	0.66%	-1.48%
Wichita, KS	1.33%	1.33%	0.00%

<u>Appendix IV:</u> Cities by Quadrant

Quadrant I	Quadrant II	Quadrant III	Quadrant IV
Baltimore, MD	*Akron, OH*	*Albuquerque, NM*	*Boston, MA*
Birmingham, AL	*Austin, TX*	*Anchorage, AK*	*Colorado Springs, CO*
Jacksonville, FL	*Chicago, IL*	*Bakersfield, CA*	*Columbus, OH*
Phoenix, AZ	*Cincinnati, OH*	*Charlotte, NC*	*El Paso, TX*
Portland, OR	*Cleveland, OH*	*Fresno, CA*	*Honolulu, HI*
Richmond, VA	*Dallas, TX*	*Greensboro, NC*	*Lincoln, NE*
Riverside, CA	*Denver, CO*	*Los Angeles, CA*	*Miami, FL*
Rochester, NY	*Detroit, MI*	*Sacramento, CA*	*Oklahoma City, OK*
St. Louis, MO	*Grand Rapids, MI*	*San Diego, CA*	*Omaha, NE*
	Houston, TX	*San Francisco, CA*	*Raleigh, NC*
	Kansas City, MO	*San Jose, CA*	*San Antonio, TX*
	Las Vegas, NV	*Stockton, CA*	*Seattle, WA*
	Minneapolis, MN		*Tampa, FL*
	Nashville-Davidson, TN		
	New York, NY		
	Pittsburgh, PA		
	Spokane, WA		
	Tucson, AZ		
	Tulsa, OK		

Appendix V: **City minus MSA Property Value Growth (2000-2004 Annualized)**

Geography	Property Value Growth
Kansas City, MO	-3.77%
Denver, CO	-2.47%
San Antonio, TX	-2.07%
New York, NY	-1.97%
Detroit, MI	-1.51%
El Paso, TX	-1.48%
Akron, OH	-0.86%
Colorado Springs, CO	-0.84%
Las Vegas, NV	-0.81%
Raleigh, NC	-0.72%
Minneapolis, MN	-0.36%
Cleveland, OH	-0.15%
Cincinnati, OH	-0.12%
Tampa, FL	0.14%
Grand Rapids, MI	0.16%
Miami, FL	0.32%
Dallas, TX	0.34%
Lincoln, NE	0.37%
Nashville-Davidson, TN	0.47%
Houston, TX	0.51%
Pittsburgh, PA	0.55%
Chicago, IL	0.56%
Seattle, WA	0.65%
Columbus, OH	0.66%
Tulsa, OK	0.87%
Honolulu, HI	0.87%
Austin, TX	1.18%
Omaha, NE	1.20%
Boston, MA	1.46%
Oklahoma City, OK	1.47%
Spokane, WA	1.76%
Tucson, AZ	1.78%
San Diego, CA	2.32%
Anchorage, AK	2.39%
Richmond, VA	2.51%
Greensboro, NC	2.60%
Sacramento, CA	2.88%
Baltimore, MD	3.04%
Fresno, CA	3.31%

Appendix V continued

Geography	Property Value Growth
Phoenix, AZ	3.48%
Riverside, CA	4.32%
Portland, OR	4.37%
Jacksonville, FL	4.60%
Charlotte, NC	4.81%
Bakersfield, CA	4.81%
San Jose, CA	4.87%
Birmingham, AL	5.11%
San Francisco, CA	5.78%
Stockton, CA	6.45%
St. Louis, MO	7.43%
Rochester, NY	8.90%
Los Angeles, CA	9.40%
Albuquerque, NM	11.54%